



Voluntary Nonpoint Source Implementation Strategies

For the

Platte River

**Andrew, Buchanan, Clay, Clinton, DeKalb, Gentry, Nodaway,
Platte, Worth Counties**

Pollutant: *Escherichia coli* Bacteria

Completed: May 29, 2025

WATER BODY SUMMARY

Name: Platte River

Location: Andrew, Buchanan, Clay, Clinton, DeKalb, Gentry, Nodaway, Platte, Worth Counties

TMDL Development Priority: High

8-digit Hydrologic Unit Code (HUC):¹

10240012 – Platte

10240013 – One Hundred and Two

Water Body Identification (WBID) and Hydrologic Class:²

WBID 312, Class P

Designated Uses:³

Irrigation

Drinking water supply

Livestock and wildlife protection

Human health protection

Warm water habitat (aquatic life)

Whole body contact recreation category B

Secondary contact recreation



Location of watershed in Missouri

Impaired Use:

Whole body contact recreation category B

Pollutant Identified on the 2022 303(d) List:

Escherichia coli (*E. coli*) (fecal indicator bacteria)

Identified Sources on the 2022 303(d) List:

Rural nonpoint sources

Length and Location of Impaired Segments:

WBID 312 142.40 miles, Mouth to State Line

¹ Watersheds are delineated by the United States Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2019). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

² For hydrologic classes see 10 CSR 20-7.031(1)(E). Class P streams maintain permanent flow even in drought periods.

³ For designated uses see 10 CSR 20-7.031(1)(F) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

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Platte River at Sharps Station with a flow of 2,000 cfs. MoDNR File Photo July 2024

1. Introduction

This implementation strategies document is a companion to the total maximum daily load (TMDL) report for Platte River which addresses elevated *Escherichia coli* (*E. coli*) bacteria concentrations that resulted in the water bodies' placement on Missouri's Section 303(d) List of Impaired Waters. This implementation strategies document suggests volunteer actions that will reduce pollutant loading in order to meet the water quality goals established in the TMDL report. The TMDL established for the impaired water body represent the *E. coli* loading capacity for Platte River, which is the maximum amount of a pollutant that a water body can assimilate and still attain and maintain water quality standards. The goal of the TMDL is to attain and maintain recreational uses in the water body. Additional watershed characteristics and *E. coli* loading targets can be found in the TMDL report, which is available on the Missouri Department of Natural Resources' website at <https://dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls>. Although this implementation document is drafted primarily to implement the goals of the *E. coli* TMDL, this document also addresses nutrient loading. Many of the practices suggested in this document will reduce both *E. coli* and nutrient loading. This information is provided for informational purposes only to guide watershed management planning activities and the implementation of best management practices (BMPs). Questions regarding the TMDLs may be sent via email to tmdl@dnr.mo.gov or by calling the department's Watershed Protection Section at 573-751-5723.

This document neither prescribes nor prohibits any specific practices or technologies for reducing pollutant loading in the impaired water body and is not intended to serve as a comprehensive plan or the sole means of remediation and restoration. The department recognizes that technical guidance and support are critical to achieving the goals of any TMDL. Therefore, while the TMDL calculates the maximum pollutant loading that the impaired stream can assimilate and still attain and maintain water quality standards, this strategies document provides additional information to assist in meeting the TMDL loading goals including pollutant reduction strategies, example calculations of pollutant reductions, potential participants in the watershed, and funding sources. The TMDL addresses pollutant loading from all potential sources in the watershed, however, this strategies document is primarily intended to provide guidance for meeting nonpoint source loading targets.⁴ The department addresses point source pollutant reductions through the Missouri State Operating Permit program.⁵

Watershed management practices that reduce nonpoint source pollutant loading are conducted voluntarily by interested groups and landowners within the watershed. In accordance with Section 319 of the federal Clean Water Act, the United States Environmental Protection Agency (EPA) provides funding for nonpoint source pollutant load reduction practices. Section 319 nonpoint source subgrants are administered by the department through Missouri's Section 319 program to assist organizations with watershed planning or implementation of activities as described in an accepted nine element watershed management plan (or alternative plan under certain specific conditions). The Nine Key Elements of a Watershed Management Plan are provided in Appendix A. More information on Missouri's Section 319 subgrant program is available at: dnr.mo.gov/water/what-were-doing/nonpoint-source-pollution-section-319. Potential government support and sources of funding are provided in Appendix B.

2. Watershed Characteristics

The Platte River watershed is located in northwestern Missouri and southwestern Iowa (Figure 1). The Platte River (WBID 312) originates about 3.25 miles northeast of Spaulding, Iowa. From here, the river runs south approximately 200 miles, 142.40 miles of which in Missouri, before flowing into the Missouri River. The total watershed area of the Platte River is composed of two 8-digit hydrologic unit code (HUC) subbasins: The One Hundred and Two Subbasin and the Platte Subbasin. The One Hundred and Two Subbasin is 776.44 square miles and its 8-digit HUC is 10240013. The Platte Subbasin is 1,663.72 square miles and its 8-digit HUC is 10240012. The portion of the total watershed located in Iowa is 786.28 square miles and the larger portion in Missouri is 1,653.88 square miles. The total watershed area of the Platte River is approximately 2,440.16 square miles.

The Platte River watershed is located within the Central Plains/Nishnabotna/Platte ecological drainage unit (EDU), which primarily consists of northwest Missouri and southwest Iowa

⁴ Point and nonpoint sources are defined and discussed in Sections 5.1 and 5.2 of the TMDL report for Platte River.

⁵ The Missouri State Operating system is Missouri's program for administering the federal National Pollutant Discharge Elimination System (NPDES) program. The NPDES program requires all point sources that discharge pollutants to waters of the United States to obtain a permit. Issued and proposed operating permits are available online at <https://dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees>

(MoRAP 2005). Ecological drainage units are groups of watersheds that have similar biota, geography, and climate characteristics (Anderson et al. 1999).

The Platte River watershed is also located in the Rolling Loess Prairies EPA Level IV ecoregion. Ecoregion is defined in Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(H) as "...areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance." The Rolling Loess Prairies ecoregion is characterized by loess deposits on well drained plains and open low hills. Loess deposits are generally less than 25 feet in depth except along the Missouri River where deposits are thicker. Natural vegetation consists of tallgrass prairie and areas of oak-hickory forest, although cropland agriculture is widespread (Chapman et al. 2002).

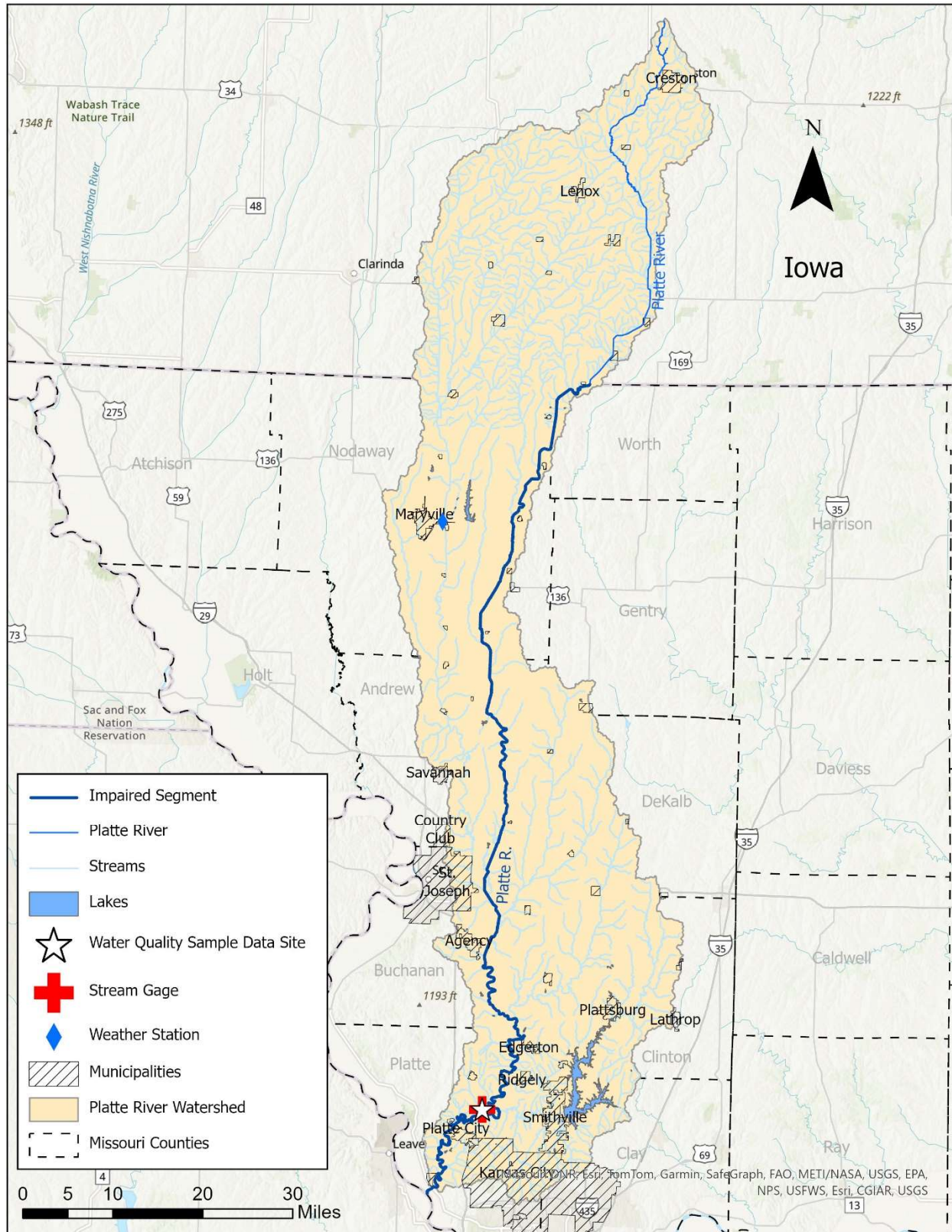


Figure 1. The Platte River watershed

Land cover types present in the Platte River watershed are shown in Table 1. Figure 2 depicts the distribution of the land cover types throughout the watershed. Agricultural lands are the dominate land use which accounts for approximately 78.75 percent of the total watershed area while developed areas account for 6.39 percent of watershed area.

Table 1. Land cover in the Platte River watershed

Land Cover Type	Total Watershed		Missouri Only	
	Area Square Miles	Percent	Area Square Miles	Percent
Developed, High Intensity	5.97	0.24%	5.40	0.33%
Developed, Medium Intensity	18.22	0.75%	15.42	0.93%
Developed, Low Intensity	60.69	2.49%	45.29	2.74%
Developed, Open Space	71.11	2.91%	52.70	3.19%
Barren Land	1.30	0.05%	1.21	0.07%
Cultivated Crops	1,199.56	49.15%	680.33	41.13%
Hay and Pasture	722.48	29.60%	563.79	34.09%
Shrub and Herbaceous	9.43	0.39%	5.26	0.32%
Forest	280.14	11.48%	222.96	13.48%
Wetlands	44.79	1.84%	38.05	2.30%
Open Water	27.06	1.11%	23.57	1.42%
Totals	2,440.74*	100.00%	1,653.97*	100.00%

*Due to rounding and data resolution, these values differ slightly from the calculated watershed area.

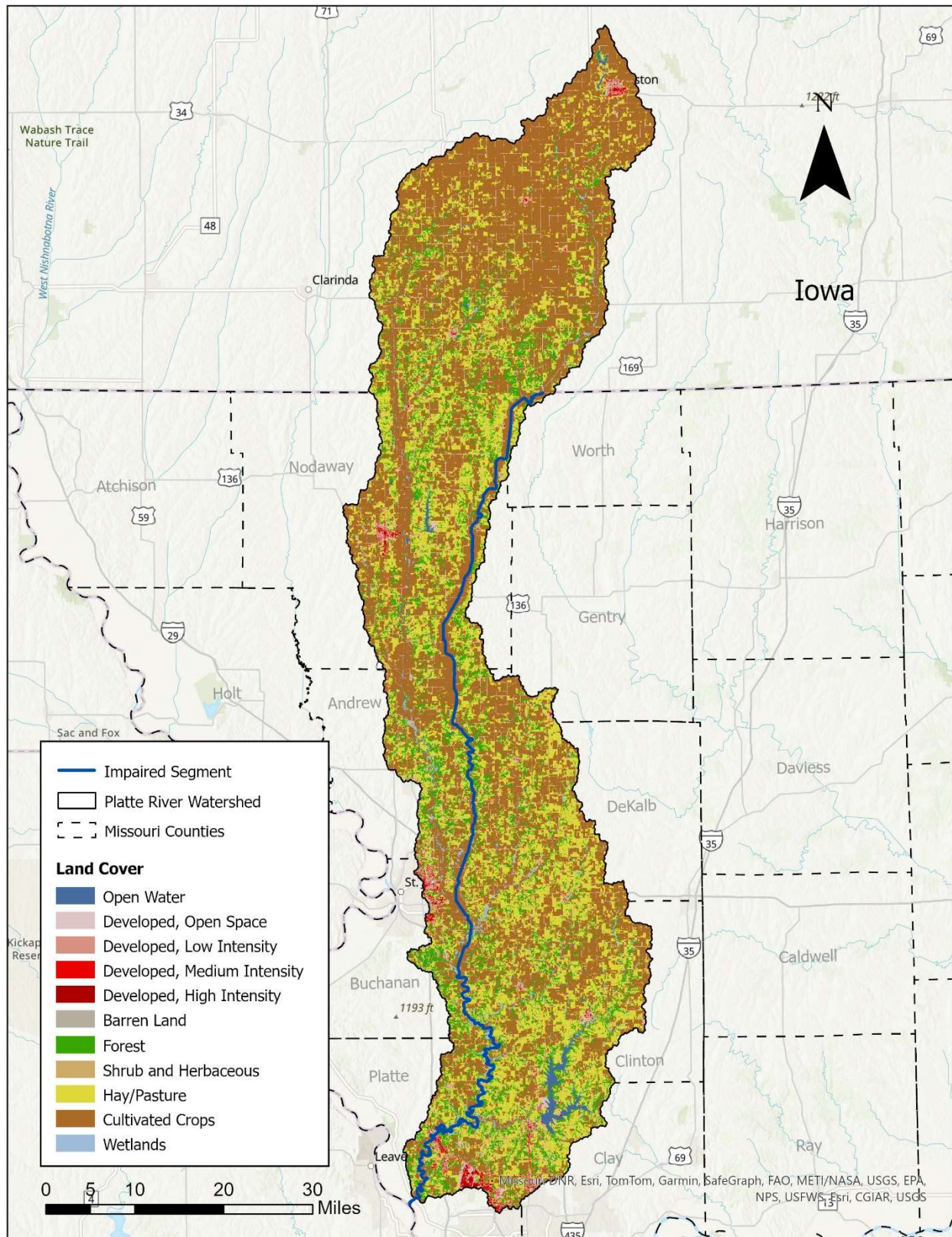


Figure 2. Land cover in the Platte River watershed

3. Water Quality Impairments

Water quality criteria represent a level of water quality that supports and protects protect designated uses. Specific numeric *E. coli* bacteria criteria are given in Missouri's Water Quality Standards at 10 CSR 20-7.031(5)(F) and Table A1. *E. coli* are bacteria found in the intestines of humans and warm-blooded animals and are used as indicators of potential fecal contamination and risk of pathogen-induced illness to humans. For whole body contact recreation category B waters, *E. coli* concentrations during the recreational season (April 1st through October 31st) shall not exceed the geometric mean of 206 colony-forming unit (cfu) per 100 milliliter (mL) of water.

Whole body contact recreation includes activities that involve direct human contact with waters of the state to the point of complete body submergence (10 CFR 20-7.031(1)(C)2.A.). During such activities, such as swimming, accidental ingestion of the water may occur and there is direct contact to sensitive body organs, such as the eyes, ears, and nose. Whole body contact category B applies to waters designated for whole body contact recreation not contained within category A (10 CSR 20-7.031(1)(F)2.A.(II)). Secondary contact recreation, which includes activities such as boating, fishing, and wading, are activities that may result in contact with the water that is either incidental or accidental and the probability of ingesting appreciable quantities of water is minimal (10 CSR 20-7.031(1)(F)2.B.). The department determines that a stream is impaired for *E. coli* bacteria when the water quality criteria are exceeded in any of the last three years for which there is a minimum of five samples collected during the recreational season. This approach is detailed in the department's 2022 Listing Methodology Document, which is available online at <https://dnr.mo.gov/document-search/methodology-development-2022-section-303d-list-missouri>.

In accordance with Missouri's 2022 Listing Methodology Document, the whole body contact recreation category B designated use for Platte River is impaired. Sufficient data consistent with the assessment methodology are available to support these listings as summarized in Table 2. As shown, Platte River *E. coli* concentrations exceeded the criterion in 2007 and 2019. A summary of recreational season *E. coli* data used to assess water quality in the Platte River is displayed in Table 2 and Figure 3.

Table 2. Summary of available recreational season *E. coli* data for the Platte River⁶

Recreation Season	Number of Samples	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Geometric Mean* (cfu/100 mL)
2007	5	120	1600	211
2008	3	510	2,600	1,032
2009	4	72	6,000	692
2010	4	320	1,600	643

⁶ *E. coli* data may be reported in units of most probably number (MPN) or colony forming units (cfu) depending upon the analysis method used. Data reported as cfu is an actual count of bacteria colonies, whereas MPN is a statistical approximation. Although differences may exist, they are often used interchangeably. For simplicity, and to maintain consistency with Missouri Water Quality Standards, all *E. coli* data in this TMDL are presented in units of cfu regardless of the methodology used.

Recreation Season	Number of Samples	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Geometric Mean* (cfu/100 mL)
2011	4	30	1,200	78
2012	4	74	1,700	244
2013	4	35	10,000	388
2014	4	420	6,400	1,765
2015	4	40	1,600	278
2016	4	310	7,900	1,686
2017	4	140	26,000	2,588
2018	4	35	6,800	608
2019	5	54	10,000	1,056
2020	4	90	15,000	1,612

* Although geometric means are presented for all years of available data, only years with a minimum of five samples were used for assessment purposes.

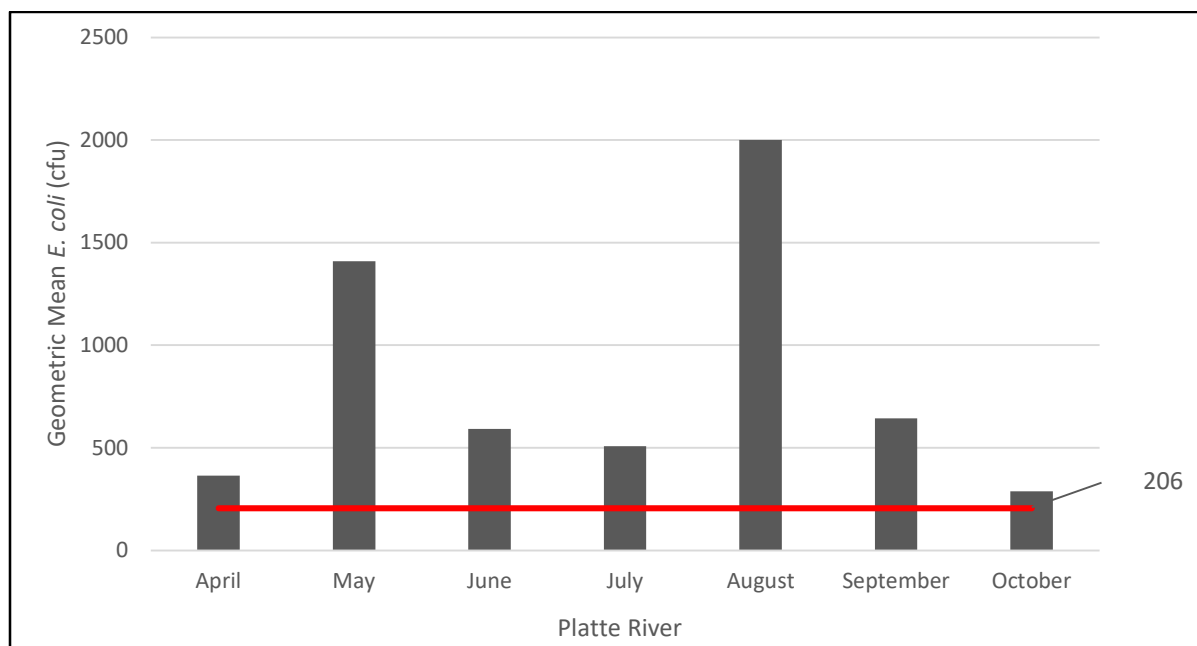


Figure 3. Geometric means for *E. coli* by month from 2007-2020

4. Causes and Sources of Pollutant Loads

Section 5 of the Platte River *E. coli* TMDL provides an inventory and assessment of all known and suspected point and nonpoint sources of bacteria loading in the watershed. The bacteria sources identified in the TMDL document are based on issued permits and a general knowledge of watershed conditions. For some sources, specific loading contributions remain unknown. Groups interested in implementing BMPs in the watershed may want to consider employing microbial source tracking techniques to better identify the primary sources of *E. coli* in their area (i.e., humans, poultry, equine, cattle, feral hogs, domestic pets, or wildlife). However, such techniques can be cost-prohibitive and may be unnecessary if localized land use activities or specific contributing sources are already well known. More information regarding microbial source tracking techniques is available online from the United States Geological Survey (USGS) at <https://www.usgs.gov/labs/ohio-water-microbiology-laboratory/microbial-source-tracking>. Potential nonpoint sources identified in the TMDL as potential contributors to the impairment include stormwater runoff associated with agricultural and riparian areas, wildlife, and discharges from failing onsite wastewater treatment systems.

4.1 Agricultural Areas

Croplands, pasturelands, and low-density animal feeding operations are potential sources of bacteria in surface waters. Bacteria are transported in runoff from areas fertilized with animal manure and where livestock are present. Runoff can result from precipitation or excessive irrigation. Section 640.760 Revised Statutes of Missouri (RSMo) establishes setback distances for surface application of liquefied manure from a Concentrated Animal Feeding Operation (CAFO) by a third party.⁷ Pursuant to Section 640.760 RSMo, the department may enforce stricter setbacks. Soil and Water Conservation Districts provide funding and guidance for the development of nutrient management plans for private lands. Areas where nutrient management plans guide manure application and where BMPs are used to reduce soil erosion contribute less bacteria to surface waters than unmanaged areas. Although grazing areas are typically well vegetated, livestock tend to congregate near feeding and watering areas and create barren areas that are susceptible to erosion (Sutton 1990). Livestock that are not excluded from streams deposit manure and thus bacteria directly into waterways.

As shown previously in Table 1 and Figure 2, approximately 41 percent of the watershed is cropland and 34 percent of the watershed is pastureland in Missouri. Aside from livestock present in permitted CAFOs, the exact type and number of livestock present in the Platte River watershed is unknown. The number of cattle in each watershed can be estimated from county cattle population numbers provided in the United States Department of Agriculture's 2022 Census of Agriculture. Using the total number of cattle in Andrew, Buchanan, Clay, Clinton, DeKalb, Gentry, Nodaway, Platte, Worth Counties, and the proportion of each county's pastureland area in the watershed to the total pastureland area in each county, it is estimated that there are 71,262 cattle on the Missouri side of the Platte River watershed (NASS 2022). The United States Department of Agriculture estimates that a 1,000-pound beef cow produces approximately 64.1 pounds of manure per day (NRCS 2014). Another study found that one gram

⁷ Section 640.760 RSMo setback distances are: 50 feet from a property boundary, 300 feet from any public drinking water lake, 300 feet from any public drinking water intake structure, 100 feet from any perennial and intermittent streams without vegetation abutting such streams, and 35 feet from any perennial and intermittent streams with vegetation abutting such streams.

of fresh manure from a cow on pasture contains a population of approximately 758,577 *E. coli* (Weaver et al. 2005).

Other types of livestock such as horses, sheep, goats, pigs, and poultry may also be contributing bacteria loads in the Platte River watershed. While the number and distribution of pigs in the watershed cannot be estimated from available data, an estimation of the total number of horses, sheep, goats, and poultry is displayed in Table 3.

Table 3. Estimation of livestock in Platte Watershed per County

County	Horses	Goats	Sheep	Poultry
Andrew	249	554	239	616
Buchanan	345	172	260	494
Clay	211	248	85	425
Clinton	341	249	489	1552
DeKalb	125	108	188	806
Gentry	18	33	38	200
Nodaway	367	1028	1592	2071
Platte	235	155	270	665
Worth	9	8	9	16
Total	1901	2554	3169	6845

4.2 Riparian Corridor Conditions

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the attenuation of pollutants in runoff. Land cover within 100 feet of streams in the Platte River watershed is presented in Table 3. Agricultural lands (Hay/pasture and cultivated crops) constitute over 55 percent of the riparian corridor of streams in the entire Platte River watershed and just under 40.93 percent of riparian corridor in streams on the Missouri side of the Platte River watershed. Agricultural land located in areas where soils have a low infiltration rate and high runoff potential (Group C/D and Group D soils) may be more susceptible to *E. coli* loading and are considered priority riparian corridors. These priority riparian corridors in the Missouri side of the Platte River watershed can be found in Appendix E. Approximately 29.82 percent of the riparian corridors are forested. This indicates that some *E. coli* transported from adjacent lands may be intercepted before it enters the streams. Ground truthing or stream surveys should be conducted to confirm streambank and buffer area conditions prior to initiating implementation planning. Further discussion of riparian corridor benefits are presented in Section 6.2.1.

Table 4. Land cover in the Riparian Corridor of the Platte River Watershed

Land Cover Type	Total Watershed		Missouri Only	
	Area Square Miles	Percent	Area Square Miles	Percent
Developed, High Intensity	0.14	0.05%	0.13	0.06%
Developed, Medium Intensity	0.82	0.29%	0.73	0.36%
Developed, Low Intensity	4.30	1.54%	3.41	1.66%
Developed, Open Space	6.00	2.15%	4.82	2.34%
Barren Land	0.08	0.03%	0.07	0.04%
Cultivated Crops	86.18	30.89%	50.98	24.78%
Grassland and Pasture	67.40	24.16%	52.70	16.15%
Shrub and Herbaceous	0.91	0.33%	0.66	0.32%
Forest	83.19	29.82%	67.27	32.70%
Wetlands	19.96	7.16%	16.27	7.91%
Open Water	10.00	3.58%	8.69	4.22%
Total	278.96	100%	205.75	100%

4.3. Onsite Wastewater Treatment Systems

The onsite wastewater treatment program or local onsite wastewater authority, typically the county health department, has jurisdictional authority for domestic wastewater treatment systems when the maximum daily flow of domestic wastewater is less than or equal to 3,000 gallons per day, for individual systems with subsurface soil dispersal serving a single-family residence, and individual lagoons that serve no more than a single-family residence. Most onsite wastewater treatment (septic) systems in the Platte River watershed are regulated by the local county health departments. Properly functioning onsite residential wastewater treatment systems should not contribute significant amounts of *E. coli* to surface waters.

Traditional septic systems are generally composed of several parts: tank(s) to contain liquid and allow settling of solids, a drainage (adsorption) field where liquid wastewater infiltrates the ground, and a filter to keep solids from entering the drainage field. All three of these parts must be in good order for a septic system to function properly. The removal of bacteria occurs mainly in the adsorption field by filtration and mortality. Failing systems, however, may be sources of bacteria during wet or dry weather. Factors that may make septic systems ineffective include age, inadequate land area, poor soil for drainage, high water table, and inadequate maintenance. It is unknown how many onsite wastewater treatments systems are failing or how much bacteria they may be contributing. Proper maintenance of onsite residential wastewater treatment systems including septic tanks, associated drain fields, and household lagoons should minimize bacteria loading to surface waters. Additional resources and EPA guide to septic systems may be found at <https://www.epa.gov/septic>.

4.4 Natural Background and Wildlife

Wildlife such as deer, waterfowl, raccoons, rodents, and other animals contribute to the natural background concentrations of *E. coli* that may be found in a water body. Such contributions may be a component of runoff from agricultural areas, developed areas, forest lands, and other areas. While typical wildlife populations are not expected to cause or contribute to water body

impairments, animals that congregate in large groups on or near water bodies may contribute significant bacteria to surface waters. For instance, Canada geese have been found to contribute significant bacteria loads in some waters (Ishii et al. 2007). There are no watershed-specific population data for Canada geese or other waterfowl, but the Missouri Department of Conservation conducts statewide surveys in fall and winter. During 2023 - 2024, waterfowl counts ranged from approximately 136,408 in October 2023 to 1,181,040 in early January 2024 (MDC 2024a).

The exact number of deer in the watershed is also not known, but the Missouri Department of Conservation keeps harvest records by county for each hunting season. Harvest data provides a general idea of the number of deer that may be present in an area. The yearly harvests for the 2023 – 2024 season on the Missouri side of the Platte River watershed was approximately 1115 in Andrew County, 890 in Buchanan County, 1117 in Clay County, 889 in Clinton County, 1058 in DeKalb County, 1610 in Gentry County, 1433 in Nodaway County, 1209 in Platte County, and 1175 in Worth County (MDC 2024b). Background concentrations of bacteria may also be present in benthic sediments and, if disturbed, can be resuspended as bacteria lives longer in the sediment than in water (Davis & Barr 2006; Marino & Gannon 1991). Resuspension has been found to occur during sediment disturbance and activities such as dredging, boating in shallow area, and swimming. The significance of any resuspended bacteria to the impairment in the Platte River is unknown. Natural background contributions are included in the nonpoint source load allocation.

5. Existing Loads and Needed Reductions

Total maximum daily load targets are based on the applicable *E. coli* criteria for the protection of recreational uses in each stream. These targets are represented in Section 7 of the TMDL using load duration curves. Observed data are plotted on the load duration curve graphs to demonstrate the magnitude of existing loading and can be used to estimate the amount of pollutant reduction needed to meet the target and attain water quality standards. Points above the curve exceed the loading capacity and points on or below the curve are in compliance with water quality standards. The load duration curves also help to identify and differentiate between storm-driven loading and the presence of continuous loading. Storm-driven loading is expected under wet conditions when precipitation and runoff are high. Continuous loading is often evident at low flows when point source discharges have greater influence on water quality. When no point sources are present, low flow exceedances may be due to onsite wastewater treatment systems or livestock entering the stream. In Platte River, bacteria reductions are needed during moist and high flow conditions. Therefore, BMPs that address stormwater runoff will address the most significant sources of pollutant loading to the stream. Additional water quality monitoring conducted during watershed planning may help determine specific areas, or “hot spots,” where significant loading is occurring and where BMPs may be the most effective. Groups wishing to develop a monitoring component to any localized watershed plan are encouraged to consult with the department’s Water Quality Monitoring and Assessment Unit, available at 573-522-4505.

5.1 *E. coli* Bacteria

The *E. coli* TMDL for the Platte River is represented by a load duration curve that quantifies the loading capacity of the water body at all possible flows. Table 4 summarizes the TMDL at selected flows and the load reductions that are needed to meet the TMDL targets. The load

reductions were calculated based on the geometric mean of observed *E. coli* data recorded during each selected flow regime. A geometric mean was used to remain consistent with Missouri's *E. coli* criteria. The target concentration used is 206 cfu/100 mL to be protective of Platte River's designated use of whole body contact recreation category B. As shown, *E. coli* concentrations do exceed water quality criterion during all flow conditions with samples.

Table 5. Platte River *E. coli* TMDL and Needed Reductions

Percent of Time Flow is Equal or Exceeded ⁸	Flow Condition	Median Flow (cfs)	TMDL (counts/day)	Existing Load (counts/day)	Needed Reduction (counts/day)	Needed Reduction (%)	Existing Concentration Geometric Mean (cfu/100 mL)
100-90	Low Flow	67.04	3.38E+11	1.09E+11	0.00E+00	0.00%	66
90-60	Dry Conditions	248.62	1.25E+12	4.45E+11	0.00E+00	0.00%	73
60-40	Mid Range	618.23	3.12E+12	1.93E+12	0.00E+00	0.00%	128
40-10	Moist Conditions	1,686.06	8.50E+12	3.41E+13	2.56E+13	75.06%	826
10-0	High Flow	8,023.81	4.04E+13	7.65E+14	7.25E+14	94.72%	3,899

6. Implementation

Pollutant reductions from nonpoint sources to improve water quality are dependent upon voluntary actions and support from local communities and landowners in the watershed. The strategies described in this document are intended as guidance to local governments, regional planning commissions, private landowners, and citizen groups for achieving the load allocations targets established in the TMDL. This guidance does not establish any legal requirements or regulations for controlling nonpoint sources.

6.1 Nonpoint Source Management Activities Previously Implemented

The Missouri Soil and Water Conservation Program provides cost-share for a variety of BMPs that support reductions of *E. coli* loading from agricultural lands. Many soil and water conservation management practices that reduce erosion also reduce *E. coli* and nutrient loading. Table 6 summarizes the types of practices implemented in the Platte River watershed between 2018 and 2024.

⁸ The percent of time flow is equaled or exceeded is a statistical measure used to divide the load duration curve into flow ranges that are indicative of low flow, dry conditions, mid-range, moist conditions, and high flows. For example, a 10% value indicates a high flow that only occurs 10% of the time.

Table 6. Soil and Water Conservation Practices in the Platte River Watershed⁹

Year	Practice	Number of Practices	<i>E. coli</i> Reduction Area (Acres)
2018	Cover Crop	114	7,379.56
	Diversion	3	37.00
	Permanent Vegetative Cover Establishment	7	106.30
	Sod Waterway	15	665.50
	Terrace System	5	62.00
	Terrace System with Tile	65	1,108.10
	Water Impoundment Reservoir	5	125.90
	Well Decommissioning	1	0.00
	Total	215	9,484.36
2019	Cover Crop	280	18,257.12
	Diversion	2	13.30
	Grazing System Fence	1	18.60
	Grazing System Water Distribution	1	18.60
	Livestock Exclusion	1	2.80
	Nutrient Management	1	119.70
	Permanent Vegetative Cover Establishment	7	247.77
	Permanent Vegetative Cover Improvement	1	10.60
	Sediment Retention, Erosion, or Water Control Structure	5	68.70
	Sod Waterway	6	370.40
	Terrace System	5	91.00
	Terrace System with Tile	61	1,008.20
	Water Impoundment Reservoir	12	310.70
	Well Decommissioning	2	0.00
	Total	385	20,537.49
2020	Cover Crop	149	10,634.17
	Diversion	7	39.60
	Field Border	1	72.60
	Permanent Vegetative Cover Establishment	15	326.00
	Permanent Vegetative Cover Improvement	1	16.50
	Sediment Retention, Erosion, or Water Control Structure	7	285.80
	Sod Waterway	12	369.43
	Terrace System	6	162.60
	Terrace System with Tile	92	1,442.20
	Water Impoundment Reservoir	21	479.70

⁹ Additional information regarding soil and water conservation cost-share practices in Missouri is available online at <https://dnr.mo.gov/land-geology/businesses-landowners-permittees/financial-technical-assistance/soil-water-conservation-cost-share-practices>.

Year	Practice	Number of Practices	<i>E. coli</i> Reduction Area (Acres)
	Well Decommissioning	1	0.00
	Total	312	13,828.20
2021	Beef and Small Ruminant Waste Management	1	0.00
	Cover Crop	128	8,107.19
	Diversion	13	142.00
	Grazing System Fence	1	22.5
	Grazing System Water Distribution	1	22.5
	Permanent Vegetative Cover Establishment	10	214.05
	Sediment Retention, Erosion, or Water Control Structure	6	55.50
	Sod Waterway	13	524.30
	Spring Development	1	0.00
	Terrace System	5	146.00
	Terrace System with Tile	80	1,285.97
	Water Impoundment Reservoir	3	124.00
	Well Decommissioning	1	0.00
	Total	263	10,644.01
2022	Beef and Small Ruminant Waste Management	1	0.00
	Cover Crop	140	10,402.13
	Diversion	18	210.80
	Field Border	1	18.70
	Permanent Vegetative Cover Establishment	9	210.92
	Sediment Retention, Erosion, or Water Control Structure	5	126.89
	Sod Waterway	5	221.80
	Spring Development	1	18.50
	Terrace System	4	77.80
	Terrace System with Tile	85	1,394.49
	Water Impoundment Reservoir	5	69.30
	Total	274	12,751.33
2023	Cover Crop	137	9,373.55
	Diversion	9	107.90
	Grazing System Water Development	1	73.40
	Grazing System Water Distribution	1	73.40
	Permanent Vegetative Cover Establishment	5	43.96
	Sediment Retention, Erosion, or Water Control Structure	4	171.90
	Sod Waterway	3	309.00
	Terrace System	2	23.00
	Terrace System with Tile	58	1,001.16

Year	Practice	Number of Practices	<i>E. coli</i> Reduction Area (Acres)
	Water Impoundment Reservoir	8	82.70
	Total	228	11,259.97
2024	Cover Crop	23	1,311.73
	Diversion	4	36.30
	Field Border	1	108.40
	Grazing System Fence	1	64.20
	Permanent Vegetative Cover Establishment	4	92.74
	Sediment Retention, Erosion, or Water Control Structure	1	3.00
	Sod Waterway	2	26.90
	Terrace System	1	4.00
	Terrace System with Tile	19	423.90
	Water Impoundment Reservoir	6	120.91
	Cover Crop	23	1,311.73
	Total	62	2,192.08

6.2 Potential Nonpoint Source Management Measures and Expected Load Reductions

Nonpoint source management measures should focus primarily on reducing *E. coli* and nutrient loading from grassland and pasture lands because loading is typically higher from these areas. Suggested nonpoint source management measures are summarized in the following sections. In addition to agricultural BMPs, appropriate care and maintenance of onsite wastewater treatment systems is expected to provide additional pollutant reductions to the impaired streams.

6.2.1 Riparian Buffers

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in erosion reduction, as well as the detention, removal, and assimilation of pollutants in runoff. Therefore, a stream with good riparian cover is better able to mitigate the impacts of high pollutant loads than a stream with poor or no riparian cover. Shade provided by riparian corridors is also important because it helps to keep water cooler and reduces temperature variation that stresses aquatic life especially during the critical low flows that typically occur in July and August. Riparian buffers have been demonstrated to reduce *E. coli* runoff (Cardoso et al. 2012, Lim et al. 2022). Riparian corridors that lack woody vegetation should be prioritized for riparian restoration. Figure 4 in Section 4.2 displays these priority riparian corridors in red. The Missouri Department of Conservation offers bulk ordering of a wide variety of bare root native seedlings¹⁰. Their catalog can help direct which species to buy for erosion control, reforestation or wetland restoration as well as directions for planting.

¹⁰ Seedling orders can be placed here <https://mdc.mo.gov/trees-plants/tree-seedlings/order-seedlings>



6.2.2 Streambank Stabilization

Streambank stabilization measures also reduce erosion. Such measures may include the installation of live stakes, coconut fiber rolls and mesh, coir rolls, bank terracing, large woody debris, and large boulders to support streambanks and reduce erosion. Integrating native shrub and tree planting with other bank stabilization measures results in long-term stabilization as the vegetative roots expand and provide further soil stability. Many resources are available to guide streambank stabilization design for specific conditions. A good initial reference is the *Army Corps of Engineers Streambank and Shoreline Protection Manual*¹¹. A study of bank stabilization on the Cedar River in Nebraska found the average streambank erosion rate before stabilization was approximately 1.5 ft²/ft and was reduced to 0.5 ft²/ft after stabilization measures were implemented (Naisargi & Mittelstet 2017).¹²



6.2.3 Livestock Exclusion

Livestock that have access to streams reduce streamside vegetation, increase barren areas, and contribute *E. coli* and nutrients directly to streams. In addition, compaction from animals contributes to poor quality aquatic habitat because the interstitial spaces in stream substrate are eliminated. Horses can also directly deposit bacteria to rivers and creeks during trail rides when crossing water bodies. Reducing time horses spend in the river at crossings and improving animal manure management are additional possibilities to lower the bacteria load. Excluding

¹¹ Army Corps of Engineer Streambank and Shoreline Protection Manual
<https://www.lrc.usace.army.mil/Portals/36/docs/regulatory/pdf/StrmManual.pdf>

¹² The Cedar River watershed is located in North Central Nebraska. The western half of the watershed is mainly grassland and sand dunes in the Sand Hills, whereas the eastern half is predominantly cropland.

livestock from streams is another way to improve water quality and aquatic habitat in the Platte River watershed.



6.2.4 Nutrient Management

Nutrient management is an effective strategy for reducing *E. coli* and nutrient loading from agricultural lands to streams and is especially important in watersheds with high proportions of pasture/hay land cover. The *Missouri Concentrated Animal Feeding Operation Nutrient Management Technical Standard* is available online¹³. The technical standard describes soil and manure testing protocols, manure application criteria including required setback distances from streams, and monitoring requirements.



The primary goal of nutrient management is to promote biomass productivity that provides profit for producers while minimizing negative environmental impacts. Over-application of nitrogen and phosphorus above the crop needs will cause these nutrients to accumulate in the soil and increase the potential for losses to the environment. Nutrient management planning minimizes the transport of *E. coli*, nitrogen, and phosphorus to surface water and groundwater by optimizing fertilizer application rates, timing, and placement, as well as accounting for all sources of nutrients.

Nutrient management plan development may be eligible for cost-share through the Soil and Water Conservation Program. Nutrient Management Plans should be developed in accordance with the Natural Resources Conservation Service (NRCS) Standards and Specifications for Nutrient Management (Code 590). Landowner assistance is available through local County Soil and Water Conservation Districts.

In general, the following are required to begin nutrient management planning:

¹³ Missouri Concentrated Animal Feeding Operation Nutrient Management Technical Standard
dnr.mo.gov/document-search/missouri-concentrated-animal-feeding-operation-nutrient-management-technical-standard-march-4-2009

- Soil samples, based on a 7-inch depth, shall be taken once every 4 years, as a minimum, to monitor the phosphorus, potassium, pH and organic matter levels and adjust nutrient application rates as needed. The pH of the soil is important because it has a direct effect on nutrient availability. Follow Iowa State University recommendations and soil testing procedures to develop a crop budget for determining crop nutrient needs. Nitrate testing using the late spring nitrate test and fall corn stalk test can be used to monitor the nitrogen management program. Soil pH levels shall be maintained near 6.5 for corn and soybeans and 6.9 for alfalfa.
- Manure analysis could be completed on an annual basis for percent of solids, total Nitrogen (N), organic N, Ammonium (NH₄), Phosphorus Pentoxide (P₂O₅), Potassium Oxide (K₂O) and pH. A more realistic nutrient content can be obtained by using the averages of three or more analysis.
- Soil tests and realistic yield potentials will be used to determine the application rate of manure so as to supply most of the crop nutrient needs through the manure and legume credits. No additional commercial phosphate or potash will be applied on soils testing high or very high in phosphorus and potassium (K). On these fields, additional commercial nitrogen will be applied as needed. This will optimize crop yield potential while minimizing nutrient runoff and nitrogen leaching.
- Sensitive areas: Commercial nutrients, manure, and organic by-products shall not be applied to frozen, snow covered ground or saturated soil on slopes greater than five percent unless erosion is controlled. Manure and organic by-products shall not be applied within 200 feet of a stream, lake, agricultural drainage well, or sinkhole unless injected or incorporated within 24 hours.
- Risk Analysis: The phosphorus index will be used to determine fields that are a high risk for phosphorus losses. Conservation and/or management practices will be used to reduce the potential for phosphorus movement off site. Soil tests will be taken every four years to determine changes in phosphorus levels.

The plan should receive periodic review to determine if adjustments or modifications are needed. At a minimum the plan will be reviewed and revised with each soil test cycle.

6.2.5 Cover Crops

Planting cover crops rather than leaving cultivated cropland barren has both economic and environmental benefits. Legume cover crops can reduce fertilizer costs because of their symbiotic relationship with soil bacteria. Specific bacteria reside within the nodules on the roots of legumes such as vetch and clover and convert nitrogen gas from the atmosphere into soil nitrogen that crops can use. This biological nitrogen fixation reduces the amount of fertilizer that needs to be purchased and applied. Applying less fertilizer to the topsoil means reduced transport of nutrients to water bodies in the watershed. Cover crops also reduce erosion by holding soil in place and reducing



top-soil crusting. The plant material left behind after cover-cropping increases water infiltration and reduces evaporation. This reduces the amount of nutrient-laden runoff, and the amount of water needed for irrigation. Moisture retention by decaying plant material also helps soils be more resilient to periodic drought conditions.

A study conducted by Zhu et al. (1989) as cited in Sharpley and Smith (1991) found that planting common chickweed, Canada bluegrass, and downy brome on Missouri soybean fields decreased water runoff by an average 44 percent. The study found that nitrogen (as nitrate) loss was reduced by an average 75 percent and soluble phosphorus runoff was reduced by an average 37 percent. Sharpley and Smith (1991) found that planting ryegrass or wheat on peanut crops for six months of the year reduced soil loss by an average of 83 percent.

6.2.6 Prairie Strips

Implementing prairie strips in croplands can reduce both soil erosion and nutrient runoff. Prairie strips include edge-of-field filter strips and infield contour buffer strips. Infield contour buffer strips' primary purpose is to reduce erosion, while edge of the field filter strips primary purpose is to filter excess nutrients and animal waste. A study conducted in Iowa found that converting 10 percent of crop field to prairie filter strips reduced average annual nitrate, total nitrogen, and total phosphorous concentrations by 35, 73, and 82 percent respectively (Zhou et al. 2014). Reductions in erosion are expected to result in reduced *E. coli* loading to surface waters.



6.2.7 Field Borders

Field borders can provide a number of conservation benefits, such as reducing soil erosion from wind and water, protecting soil and water quality and providing habitat for wildlife. These habitats, located at the edges of crop fields, can also serve to connect other buffer practices and habitats within the agricultural landscape. The United States Department of Agriculture's Farm Service Agency (FSA) runs a program called the Continuous Sign-up Conservation Reserve Program (CCRP) that provides farmers with rental payments on land set-aside for conservation buffers for a period of 10 to 15 years. Cost-share payments may also be available to help farmers with the financial burden of establishing the buffers.



6.2.8 Onsite Wastewater Treatment System Proper Maintenance and Operation

Proper maintenance of onsite residential wastewater treatment systems including septic tanks, associated drain fields, and household lagoons should minimize bacteria loading to surface waters. Additional resources and EPA guide to septic systems may be found at

<https://www.epa.gov/septic>. When a component of a septic system fails, it can lead to serious problems such as effluent backing into a home or on the surface of a yard. This is an immediate health and environmental hazard as many waterborne diseases exist in household sewage and bacteria could off into nearby water bodies. This is why proper maintenance and operation are key to avoiding these costly failures. There are a variety of types of onsite septic systems that all come with different maintenance needs and schedules depending on the size of the home and uses. The septic tank is a key feature that holds effluent between pumping and must be performed by a licensed and bonded professional. A professional should also be able to inspect your septic tank for cracks and other potential issues. For a single-family home, a septic tank should typically be cleaned or pumped every two to five years. If a homeowner knows they have a drain field or soil treatment area (STA) where pretreated wastewater is allowed to infiltrate into the soil, then that area should not be disturbed, irrigated, or driven over with anything larger than a riding lawnmower. As well as keeping trees from growing on the STA or within 50 feet of the STA. To promote proper operation, those living in the home should reduce their water usage, only flush human waste and toilet paper, avoid using mass amounts of water at once, reduce chemical cleaners, not using liquid drain cleaners for clogs, and never drain oil or grease into their septic systems (NOWRA 2023). These are just common examples of BMPs related to an onsite wastewater treatment system. Homeowners need to understand the setup of their own septic system and maintain as appropriate to minimize the concentration of bacteria released into the soil or surface waters.

For more information about the importance of proper onsite wastewater treatment system operation and the potential effects on human health and the environment, see the National Onsite Wastewater Recycling Association (NOWRA). Their website offers free online education and a convenient user guide describing types of onsite wastewater treatments systems, maintenance, landscaping, land use, and troubleshooting common problems. For onsite wastewater treatment systems, the Missouri Department of Health and Senior Services (DHSS) sets statewide minimum standards. Local counties issue construction permits and have lists of approved contractors for construction and inspection. For county specific regulations, homeowners should contact the Texas County Health Department or the DHSS for those in Dent County. Information about Missouri specific onsite wastewater treatments systems can be found on the DHSS webpage here <https://health.mo.gov/living/environment/onsite/>.

6.2.9 Public Outreach

Public outreach is a key component of any watershed-based plan. Support for nonpoint source reduction plans is generated through education and outreach activities designed to inform the public about water quality issues and what can be done to reduce pollutant loading in watersheds. The following are some activities that may be implemented to develop support and participation for watershed stewardship:

1. Hold meetings and other outreach events to inform private landowners of the available technical support and financial incentives for implementing pollutant reduction strategies.
2. Attend livestock auctions and demonstrations in the local community, and hand-out literature explaining the available technical support and financial incentives for implementing pollutant reduction strategies.

3. Develop small-scale demonstrations of pollutant reduction strategies.
4. Implement a public awareness campaign regarding water quality with public service announcements.
5. Host local watershed festivals.

7. Measurable Milestones

Measurable milestones outline time frames for the incremental implementation of pollutant reduction strategies. Attainable milestones should be established based on available funding and stakeholder participation. For point sources, milestones may be integrated into permits as schedules of compliance to allow time to plan, fund, and construct facility upgrades or implement adaptive management. Watershed-based plans should include milestones for public outreach, attaining funding, and the implementation of chosen nonpoint source management measures. Plans that are developed to procure Section 319 subgrants must be renewed every five years to stay eligible for funding. It is therefore good general practice to develop measurable milestones on 5-year timeframes. Periodic evaluations allow for an adaptive management approach that makes progress towards water quality goals, while using any new data and information to reduce uncertainty and adjust implementation activities. The following is an example of measurable milestones over a 20-year timeframe.

5-Year Milestones

- Conduct outreach, gain public participation, and explore funding options that will allow pollutant reduction strategies to be implemented.
- Develop a comprehensive watershed management plan and identify key areas for implementation.
- Procure funding and begin implementing strategies such that:
 - Nutrient management plans are developed and implemented on 10 percent of unregulated agricultural lands in the watershed, and
 - Riparian buffers, and fencing protects 10 percent of tributaries to the impaired waters.
 - 2 percent of streambanks are stabilized in key areas.
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all newly established riparian buffers are progressing toward maturity.

10-Year Milestones

- Continued outreach, public participation, and funding procurement.
- Develop and implement nutrient management plans on 25 percent of unregulated agricultural lands in the watershed,
- Construct riparian buffers, and fencing to protect 25 percent of tributaries to the impaired waters,
- Construct streambank stabilization in 5 percent of key areas, and
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all previously established riparian buffers are intact and newly established riparian buffers are progressing toward maturity.

15-Year Milestones

- Continued outreach, public participation, and funding procurement.
- Develop and implement nutrient management plans on 50 percent of unregulated agricultural lands in the watershed,
- Construct riparian buffers, and fencing to protect 50 percent of tributaries to the impaired waters,
- Construct streambank stabilization in 7 percent of key areas, and
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all newly established riparian buffers are effectively attenuating pollutants.

20-Year Milestones

- Continued outreach, public participation, and funding procurement.
- Develop and implement nutrient management plans on 75 percent of unregulated agricultural lands in the watershed,
- Construct bank stabilization, riparian buffers, and fencing to protect 75 percent of tributaries to the impaired waters,
- Construct streambank stabilization in 10 percent of key areas, and
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all previously established riparian buffers are intact and newly established riparian buffers are progressing toward maturity.

8. Cost-Benefit

Cost-benefit analyses can be conducted during the watershed management planning process to determine the most efficient investments of time, effort, and supplies. Costs associated with nutrient management plan implementation and cover crops are relatively minimal because many of the practices are already integrated into the farming system and substantial cost savings are achieved through reducing the need for manure application and chemical fertilizers. Streambank stabilization is the most expensive pollutant reduction strategy but can be limited to key areas to stabilize highly erosive streambanks for the benefit of water quality in all downstream waters.

9. Potential Government Assistance and Funding

Reducing pollutant loading to achieve TMDLs often requires participation and technical support from government agencies. Public service staff can often provide technical guidance and direct interested parties to potential funding sources. Some of the available agencies and organizations and their potential roles, including funding avenues, are listed in Table 7. The list is not exhaustive. The most commonly used sources of funding are low-interest loans through the State Revolving Fund to implement point source goals, Section 319 subgrants, and Soil and Water Conservation Program cost-share practices.

Table 7. Agency Roles and Funding Options

Agency and Roles	Funding Options
US Department of Agriculture, Natural Resources Conservation Service https://www.nrcs.usda.gov/wps/portal/nrcs/site/mo/home/	
Financial assistance and incentives to implement voluntary BMPs	Environmental Quality Incentives Program (EQIP) Regional Conservation Partnership Program (RCPP) Conservation Stewardship Program (CSP) Agricultural Conservation Easement Program (ACEP)
US Department of Agriculture's Farm Service Agency (FSA) https://www.fsa.usda.gov/	
Administers a program called the Continuous Sign-up Conservation Reserve Program (CCRP) that provides farmers with rental payments on land set-aside for conservation buffers for a period of 10 to 15 years. Cost-share payments are also made available to help farmers with the financial burden of establishing the buffers.	Continuous Sign-up Conservation Reserve Program (CCRP)
Missouri Department of Natural Resources https://dnr.mo.gov/	
Water Protection Program https://dnr.mo.gov/water/how-water Implements federal Clean Water Act regulations including: enforcing National Pollutant Discharge Elimination System (NPDES) regulations through point source facility operating permits, establishing Water Quality Standards, identifying impaired water bodies, and developing TMDLs.	Free volunteer water quality monitoring training and tools
Financial Assistance Center dnr.mo.gov/water/business-industry-other-entities/financial-opportunities/financial-assistance-center Provides technical guidance for publicly owned treatment works and administers low-interest long-term loans to assist with technology and capacity upgrades. The Clean Water State Revolving Fund provides subsidized loans to municipalities, counties, public sewer districts, and political subdivisions for wastewater infrastructure projects. Loans may be paired with grant funds for qualifying communities. Eligible projects include new construction or improvement of existing facilities. Information on the department's grant policy is available online at dnr.mo.gov/water/business-industry-other-entities/financial-opportunities .	Clean Water State Revolving Fund

Agency and Roles	Funding Options
Soil and Water Conservation Program dnr.mo.gov/env/swcp/ The Soil and Water Conservation Program (SWCP) provides financial incentives to landowners to implement practices that help prevent soil erosion and protect water quality. The program offers cost-share practices through its county conservation districts. Landowners may receive up to 75 percent reimbursement of the estimated cost of a practice through the program. The primary funding for cost-share practices from the Soil and Water Conservation Program comes from the one-tenth-of-one percent Parks, Soils, and Water Sales Tax.	SWCP cost-share
Section 319 Nonpoint Source Program dnr.mo.gov/water/what-were-doing/nonpoint-source-pollution-section-319 Provides assistance with the development of watershed-based plans and administers Section 319 subgrants for plan development and implementation.	Section 319 subgrants
Missouri Department of Conservation mdc.mo.gov/community-conservation/community-conservation-funding-opportunities/	
Offers a number of grant and cost-share options including Community Conservation Grant and Land Conservation Partnership Grant. Provides outreach, education, and technical guidance for stream and watershed management issues. Maintains Missouri Conservation lands.	Community Conservation Grant and Land Conservation Partnership Grant Free volunteer water quality monitoring training and tools
Missouri Agricultural and Small Business Development Authority agriculture.mo.gov/abd/financial/awloanprg.php	
Offers an Animal Waste Treatment System Loan Program in cooperation with the Clean Water State Revolving Fund. Animal Waste Treatment Loans Program may finance eligible animal waste treatment systems for independent livestock and poultry producers with operations of less than 1,000 animal units. Eligible costs include storage structures, land, dedicated equipment, flush systems, composters, and more.	Clean Water State Revolving Fund
University of Missouri Extension https://extension2.missouri.edu/	
Provides guidance for farm management including crop resilience, pond health, and livestock care.	Free information and assistance

Agency and Roles	Funding Options
County Soil and Water Conservation Districts https://mosoilandwater.land/	
Provides guidance and assistance with the development of nutrient management plans and procurement of funding from the state cost-share program.	Free information and assistance with grant applications
Online Databases of Additional Funding Sources	
▪ Wichita State University, Environmental Finance Center (EFC) Missouri Healthy Watershed Funding Search Tool https://www.wichita.edu/academics/fairmount_college_of_liberal_arts_and_sciences/hugowall/efc/news/meramec-funding-sources-landing-page.php ▪ Catalog of Federal Funding https://www.epa.gov/waterdata/catalog-federal-funding ▪ EPA Nonpoint Source Funding Opportunities http://water.epa.gov/polwaste/nps/funding.cfm ▪ Environmental Justice Grants https://www.epa.gov/environmentaljustice/environmental-justice-grants-and-resources ▪ Grants.gov http://www.grants.gov	

10. Conclusion

The ultimate goal of this TMDL implementation strategies document is to restore the impaired streams to conditions that meet Missouri Water Quality Standards through the protection of whole body contact recreation. Implementation strategies should follow an adaptive management approach that makes progress toward achieving water quality goals while using new data and information to reduce uncertainty and adjust implementation activities. Implementation efforts are expected to occur over a number of years, but within the schedules established in state operating permits and watershed-based plans. Success in achieving water quality standards will be determined by the department through biennial assessments of water quality compliance as required by Sections 305(b) and 303(d) of the federal Clean Water Act.

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Appendix A

Nine Key Elements Critical to a Watershed-Based Plan

- a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan, as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).
- b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).
- c. A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
- d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, United States Department of Agriculture's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.
- e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
- f. A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
- g. A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
- h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a nonpoint source TMDL has been established, whether the nonpoint source TMDL needs to be revised.
- i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Appendix B

Potential Participants and Potential Roles in Implementation

The department implements TMDL targets for point sources through the Missouri State Operating Permit program. For nonpoint sources, private landowners and citizen groups voluntarily implement water quality improvement projects and cost-share practices, which may be funded in part by grants or subgrants from the department's Section 319 Nonpoint Source Implementation Program and the Soil and Water Conservation Program. Local governments, citizen groups, and individuals who have an interest in improving water quality in their communities may implement additional water quality improvement actions. Successfully meeting the goals of a TMDL often requires participation and cooperation from various parties within a watershed. Participant roles range from technical support to actual on-the-ground implementation of BMPs. Groups and agencies that may potentially be involved in the TMDL implementation process are identified below along with descriptions of their possible roles. This list is not exhaustive and not intended to compel participation from any organizations; nor is it meant to exclude those who are not listed but may be interested in participating.

- Department of Natural Resources
 - Administers statutory authorities granted by Missouri clean water law.
 - Ensures permits issued in the watershed are consistent with the assumptions and requirements of TMDL wasteload allocations (the allowable point source load) or Provides compliance assistance to regulated entities.
 - Provides technical support to locally led watershed groups.
 - Serves as a potential source of financial assistance for watershed plan development and BMP implementation through Sections 319(h) and 604(b) grants, or through Soil and Water Program cost-share practices.
 - Serves as a potential source of financial assistance for infrastructure improvements through low-interest State Revolving Fund loans.
 - Assesses attainment of water quality standards on a biennial basis for Clean Water Act Sections 303(d) and 305(b) reporting Implementation Strategies.
 - Provides education and training to volunteers through the Missouri Stream Team Program.
 - Provides technical assistance for market-based approaches to compliance such as water quality trading.
- County Soil and Water Conservation Districts
 - Provide financial incentives to agricultural producers to implement conservation practices that help prevent soil erosion and protect water quality.
 - Provide technical assistance with design, implementation, and maintenance of conservation practices.
- University of Missouri Extension
 - Provides technical assistance for addressing nonpoint source and watershed management issues.
 - Assists with organizing locally led watershed groups.
- Missouri Department of Conservation
 - Provides technical assistance with stream and watershed management issues.

- Promotes maintenance and reestablishment of stable streambanks and functional riparian corridors.
- Missouri Department of Health and Senior Services
 - Provides technical assistance pertaining to onsite wastewater treatment systems (i.e., septic).
- County Health Departments
 - Provide technical assistance pertaining to onsite wastewater treatment systems.
- Locally led watershed groups
 - Develop and implement Section 319-funded nine key element watershed-based plans (See Appendix A).
 - Identify critical areas at a local level.
 - Implement BMPs to reduce nonpoint source pollutant loading.
 - Provide public education and outreach.
- Stream Team volunteers
 - Collect screening level water quality data (i.e., dissolved oxygen and biological monitoring) through the Volunteer Water Quality Monitoring program.
 - Provide stewardship, advocacy, and education.

Appendix C

Nutrient Load Duration Curves

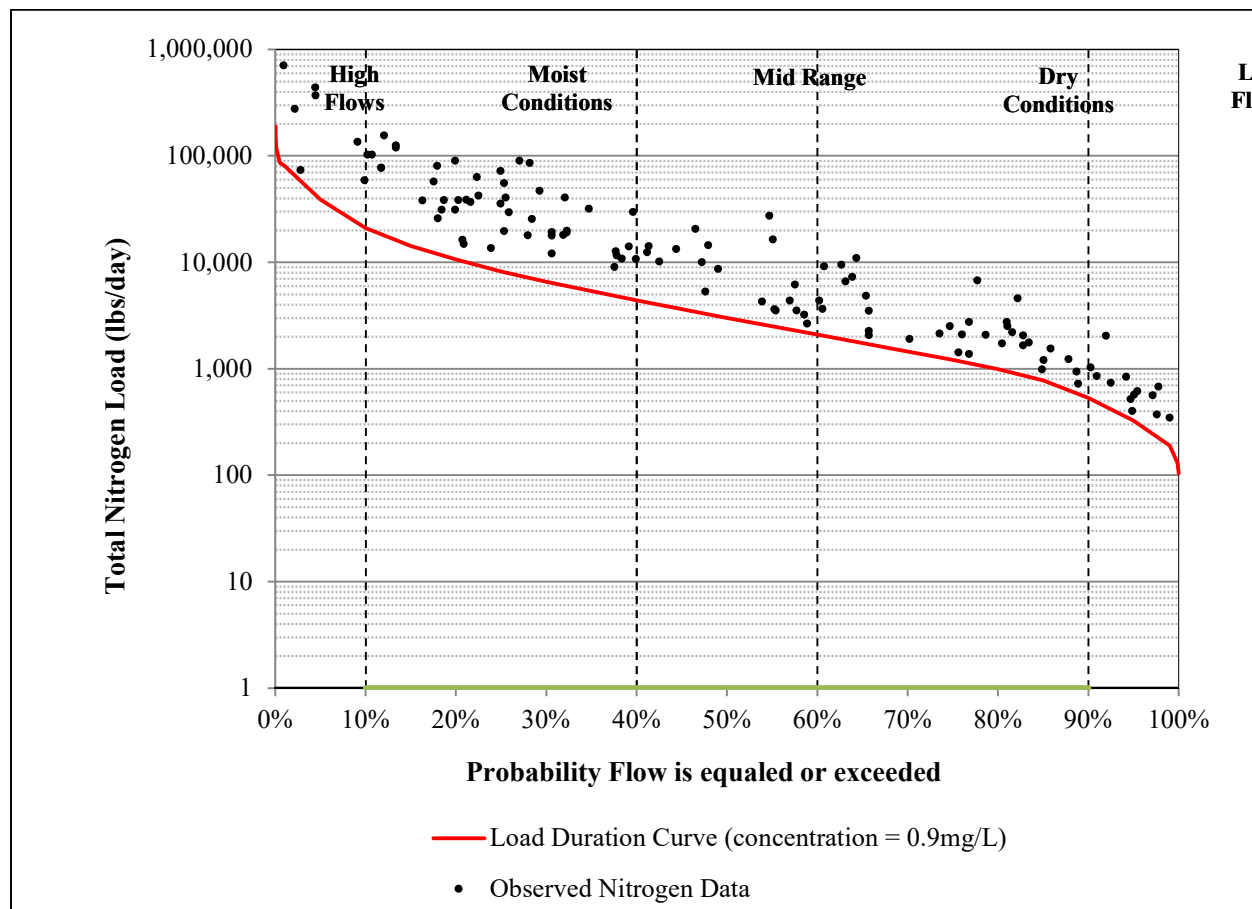


Figure C-1. Total Nitrogen load duration curve for Platte River (WBID 312)

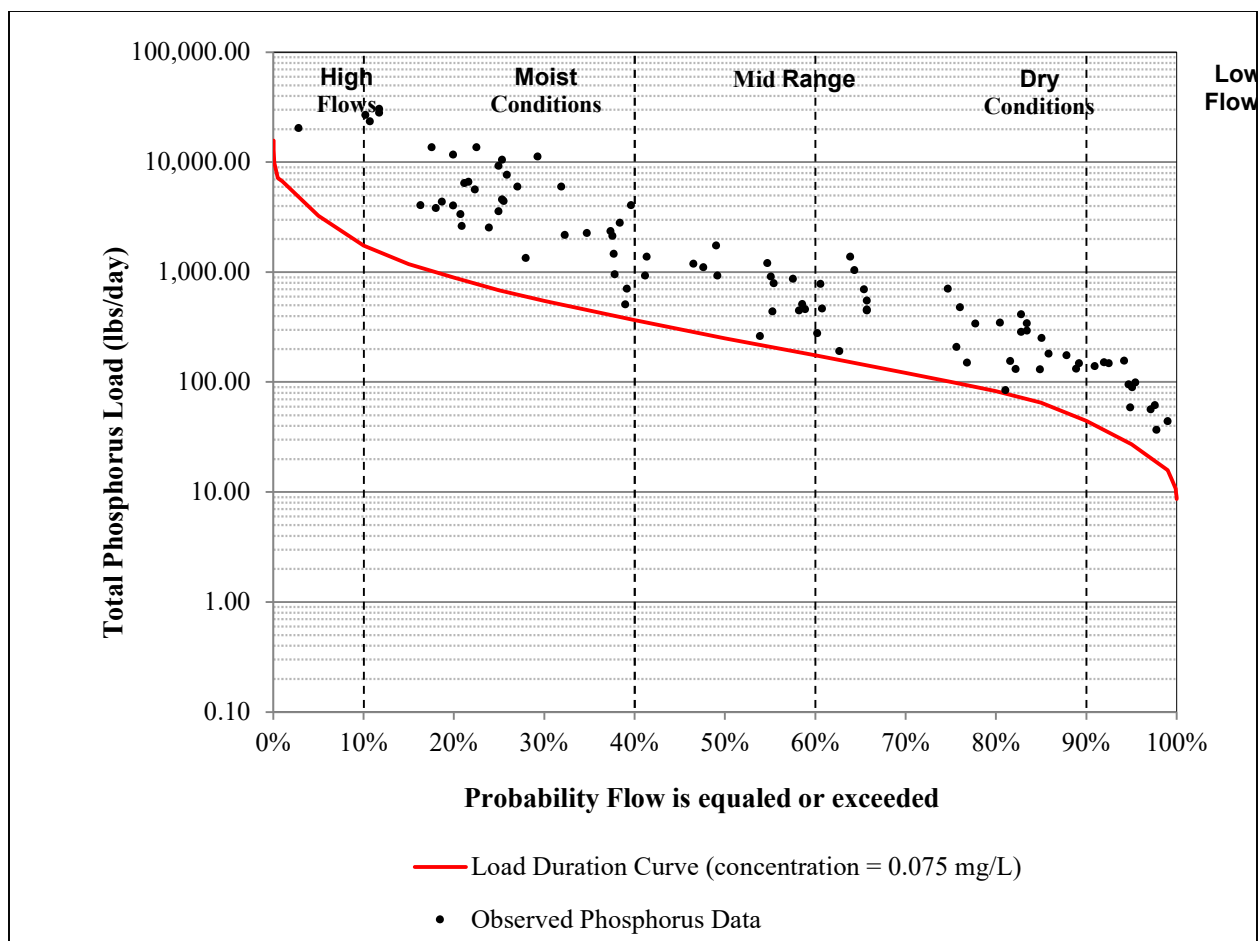


Figure C-2. Total Phosphorus load duration curve for Platte River (WBID 312)

Appendix D

Estimated Nutrient Reductions for Establishing Reduction Targets

Missouri's water quality standards do not establish nutrient criteria for streams. However, nutrient load reductions are a statewide priority, and many of the nonpoint source management measures that reduce *E. coli* loading also reduce nitrogen and phosphorus loading. Excessive nitrogen and phosphorus loading can contribute to excessive algae growth causing low oxygen levels in surface water that impairs aquatic life and contributes to bad tasting drinking water (Sharpley et al. 2003).

Nutrient targets used for load duration curves are based on benchmark values developed by the Regional Technical Assistance Group (RTAG). These benchmark values are expected to be protective of Missouri's designated uses but are not water quality criteria codified in Missouri's Water Quality Standards regulations at 10 CSR 20-7.031. In the absence of Missouri specific nutrient criteria for streams, these targets are provided only as guidance to assist watershed planning activities. Platte River is not currently identified as impaired due to nutrients and no specific nutrient reduction is required for attainment of existing applicable water quality standards. Groups developing their own watershed plans may determine that alternative, scientifically defensible, nutrient targets are more appropriate. If a TMDL is developed in the future to address nutrient pollution in Platte River, then the load allocations established in that approved TMDL should serve as the targets for watershed planning and nonpoint source nutrient reduction efforts.

Tables D1 and D2 summarize the nitrogen and phosphorous loads in the Platte River watershed at selected flows. The load reductions were calculated based on the 95th percentile of observed total nitrogen and total phosphorous that exceeded the RTAG recommendation of 0.9 milligram per liter (mg/L) of total nitrogen and 0.075 mg/L total phosphorous. The data were collected by the department from 2021-2023. Load duration curves for total nitrogen and total phosphorus are included in Appendix C.

Table D-1. Total Nitrogen Loads and Recommended Reductions

Percent of Time Flow Is Equal or Exceeded	Flow Condition	Median Flow (cfs)	Target Load (lbs/day)	Existing Load (lbs/day)	Needed Reduction (lbs/day)	Needed Reduction (%)
100-90	Low Flow	67.04	325.44	1,430	1,104	77.24%
90-60	Dry Conditions	248.62	1,206.95	9,321	8,114	87.1%
60-40	Mid Range	618.23	3,001.27	21,319	18,318	85.9%
40-10	Moist Conditions	1,686.06	8,185.14	113,422	105,236	92.8%
10-0	High Flow	8,023.81	38,952.39	631,092	592,140	93.83%

Table D-2. Total Phosphorous Loads and Recommended Reductions

Percent of Time Flow Is Equal or Exceeded	Flow Condition	Median Flow (cfs)	Target Load (lbs/day)	Existing Load (lbs/day)	Needed Reduction (lbs/day)	Needed Reduction (%)
100-90	Low Flow	67.04	27.12	152.3	125.2	82.19%
90-60	Dry Conditions	248.62	100.58	853.0	752.4	88.21%
60-40	Mid Range	618.23	250.11	1,736.6	1,486.5	85.60%
40-10	Moist Conditions	1,686.06	682.09	30,029.2	29,347.1	97.73%
10-0	High Flow	8,023.81	3,246.03	174,868.4	171,622.3	98.14%

Appendix E

Priority Riparian Corridors on the Missouri Side of the Platte River Watershed

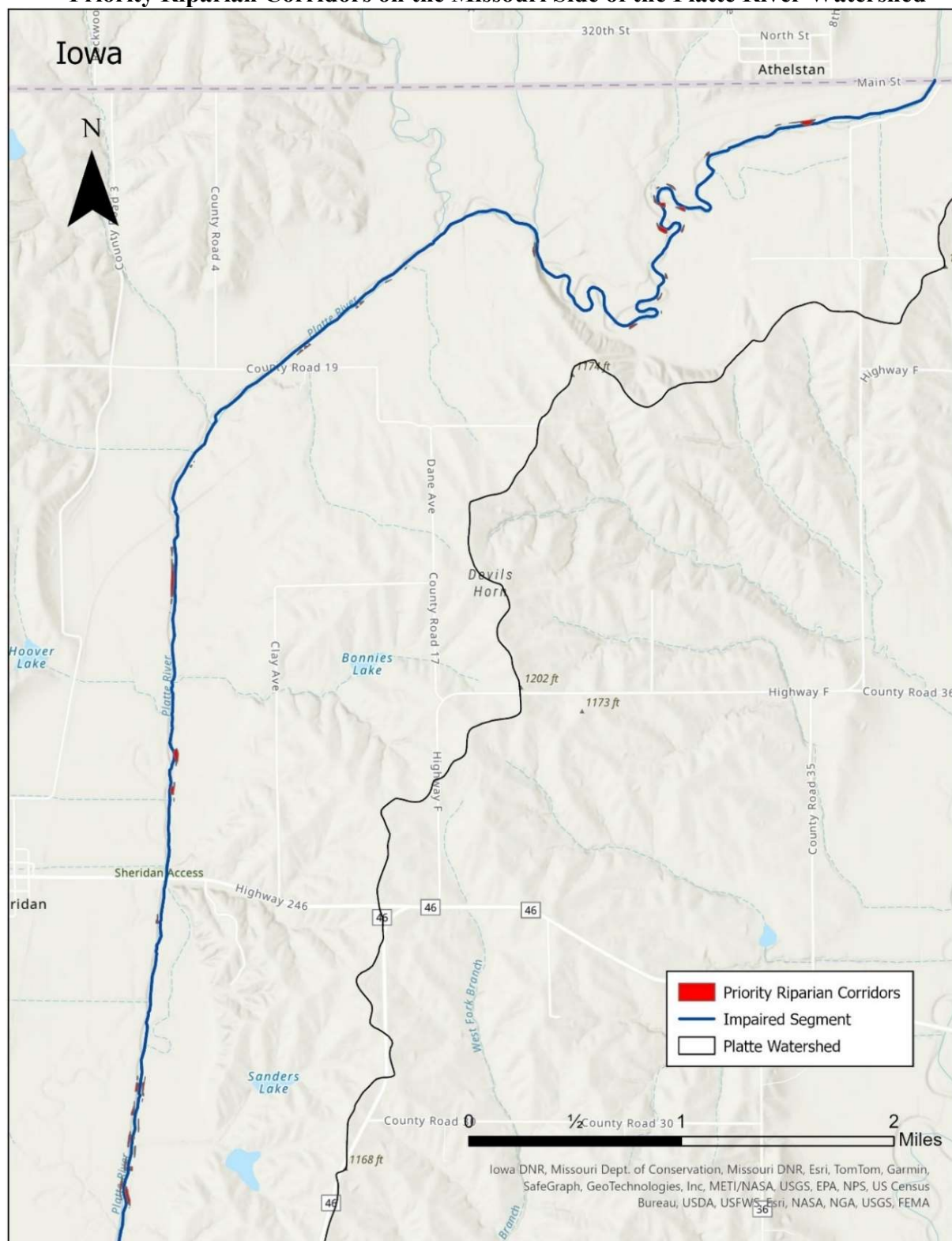


Figure E-1: Priority riparian corridors in the Platte River watershed near the Iowa/Missouri border

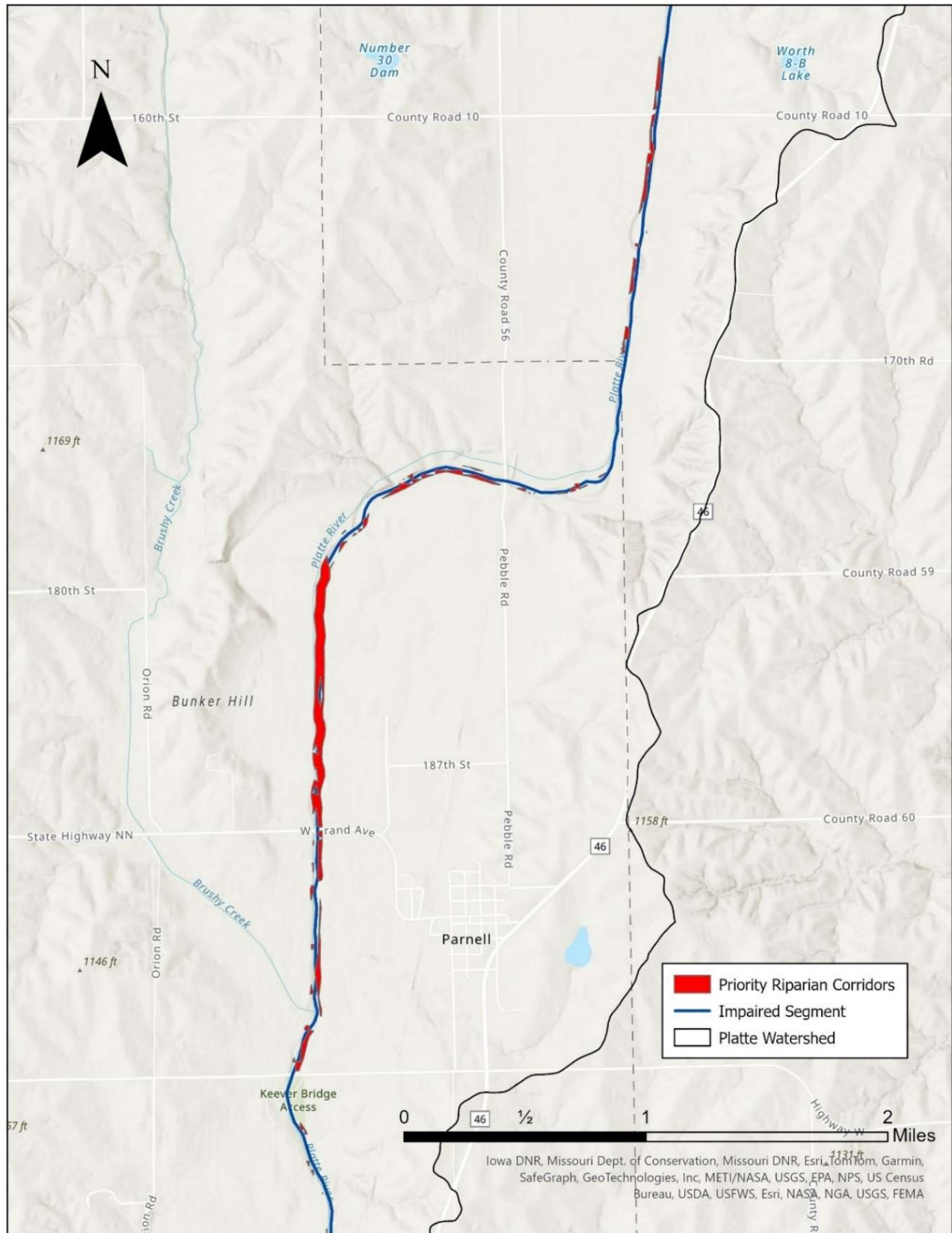


Figure E-2: Priority riparian corridors in the Platte River watershed in the northern Platte River Watershed near Parnell, Missouri

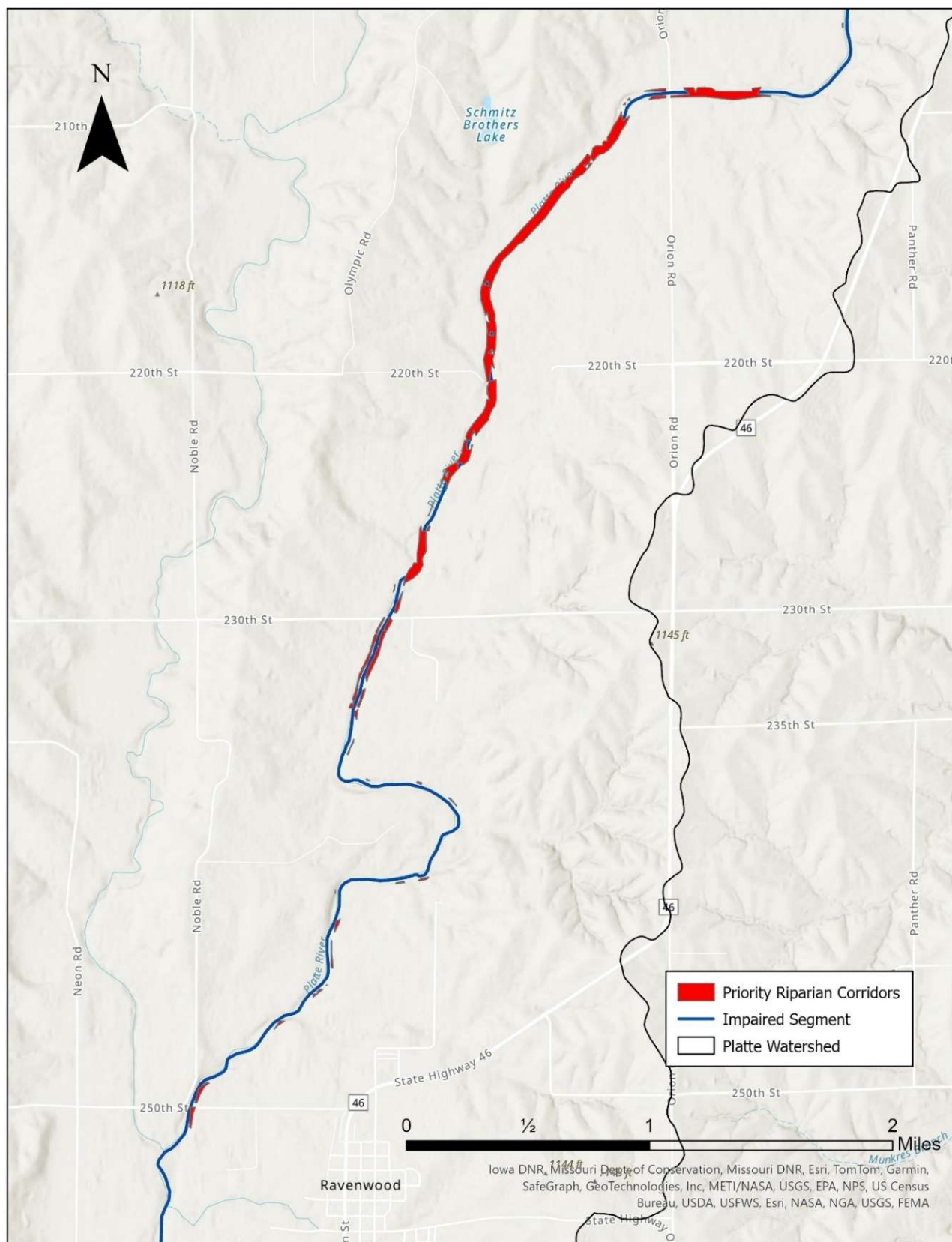


Figure E-3: Priority riparian corridors in the Platte River watershed in the northern Platte River Watershed near Ravenwood, Missouri

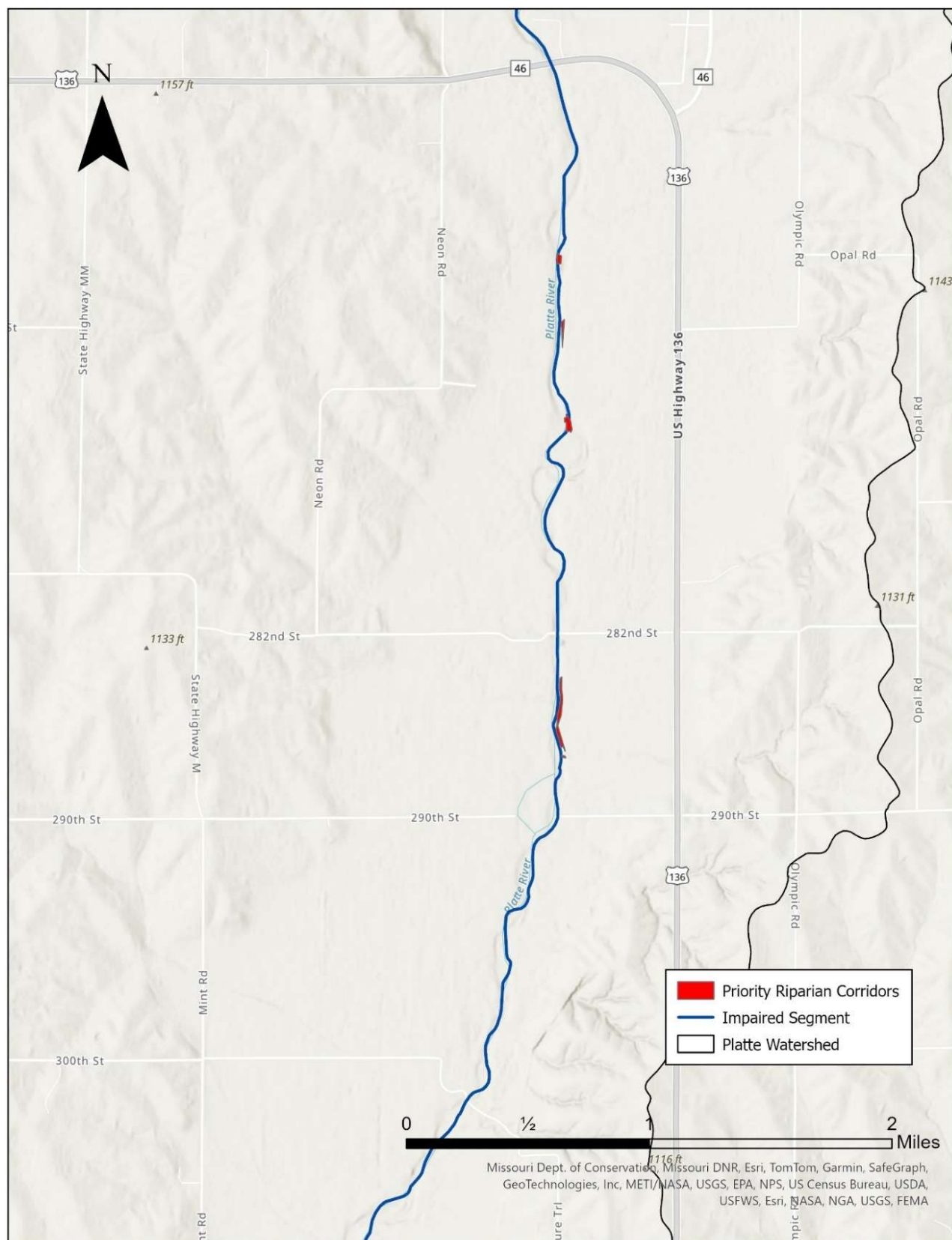


Figure E-4: Priority riparian corridors in the Platte River watershed in the north central Platte River Watershed

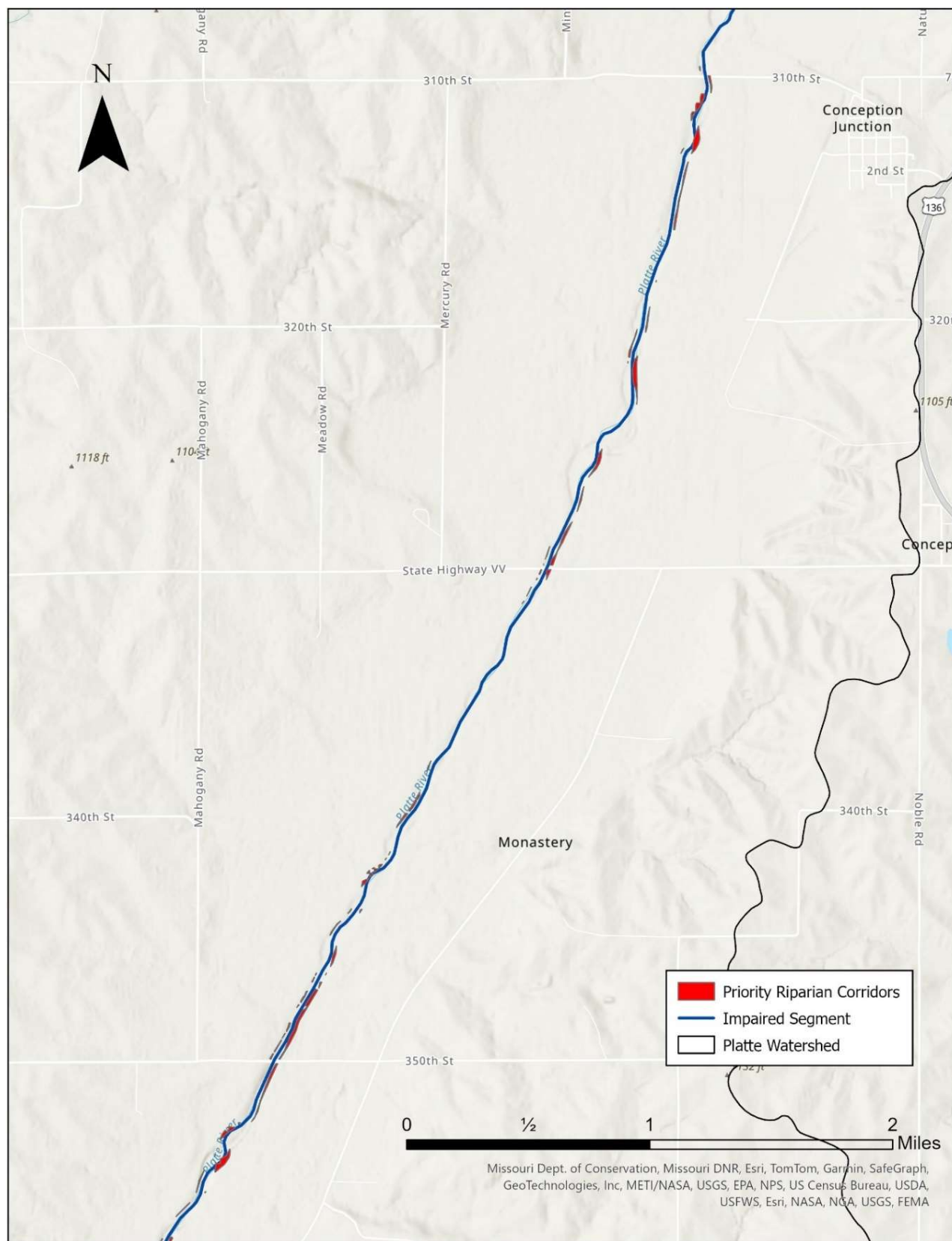


Figure E-5: Priority riparian corridors in the Platte River watershed in the north central Platte River Watershed near Conception Junction, Missouri

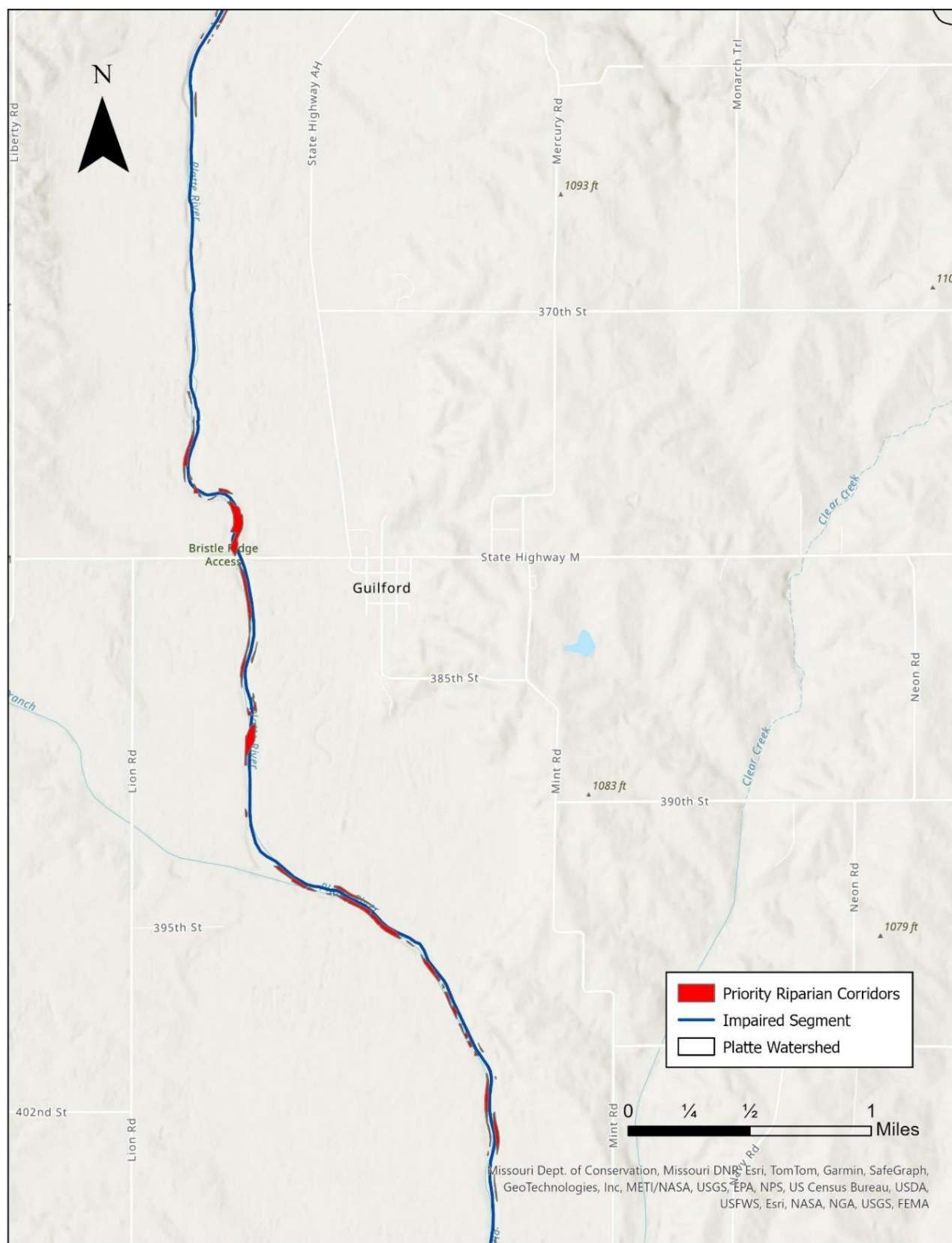


Figure E-6: Priority riparian corridors in the Platte River watershed in the central Platte River Watershed near Guilford, Missouri

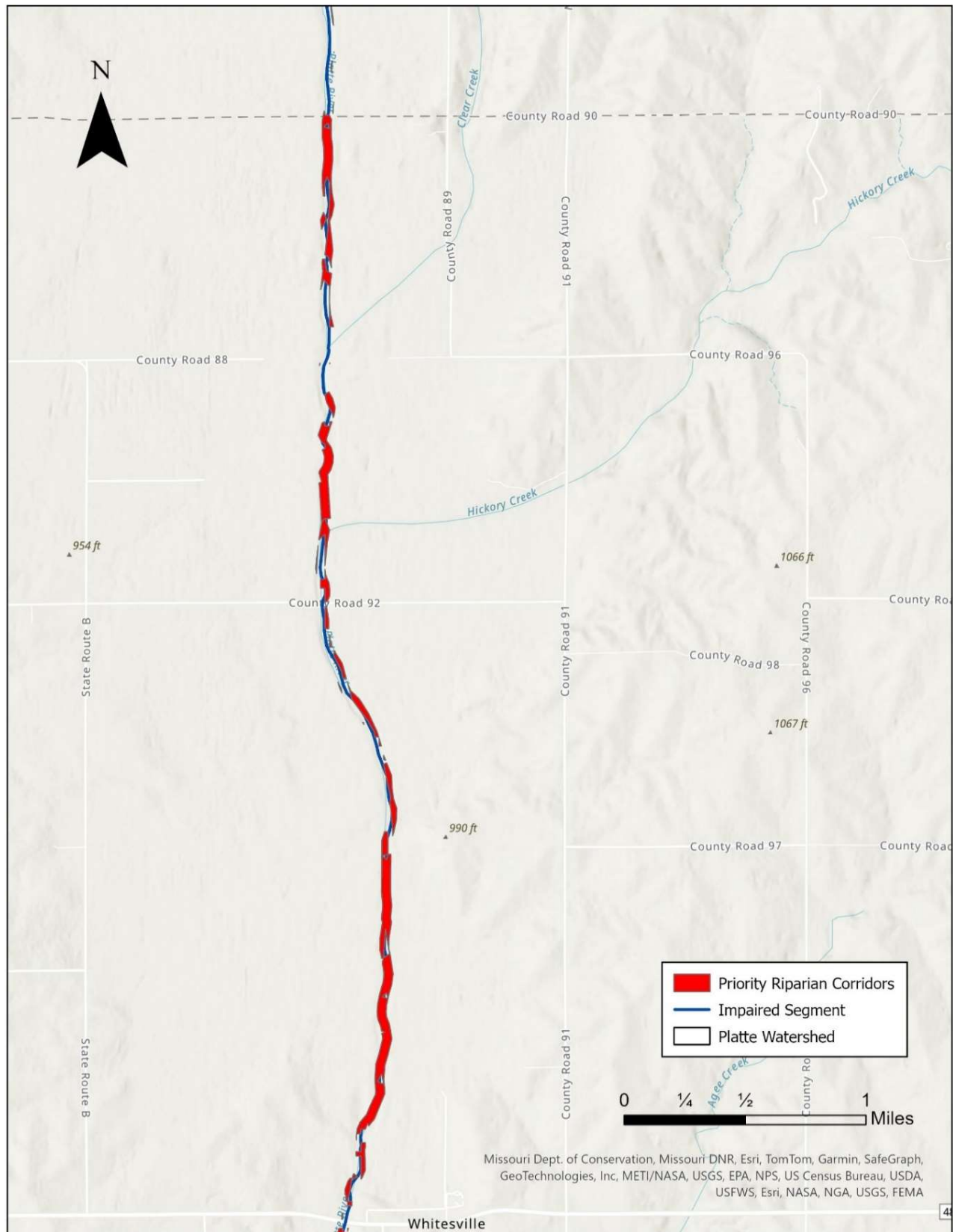


Figure E-7: Priority riparian corridors in the Platte River watershed in the central Platte River Watershed north of Whitesville, Missouri

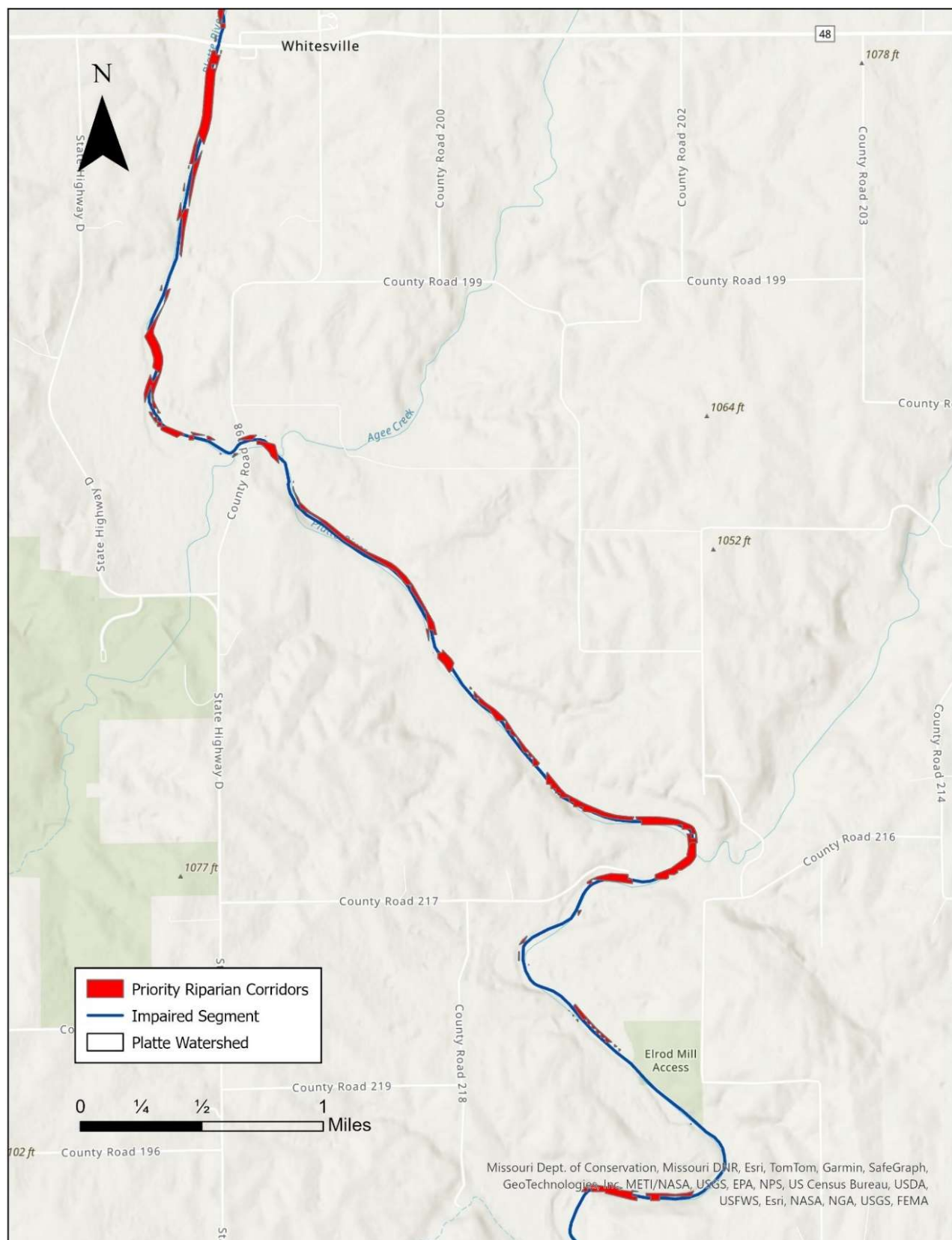


Figure E-8: Priority riparian corridors in the Platte River watershed in the central Platte River Watershed south of Whitesville, Missouri

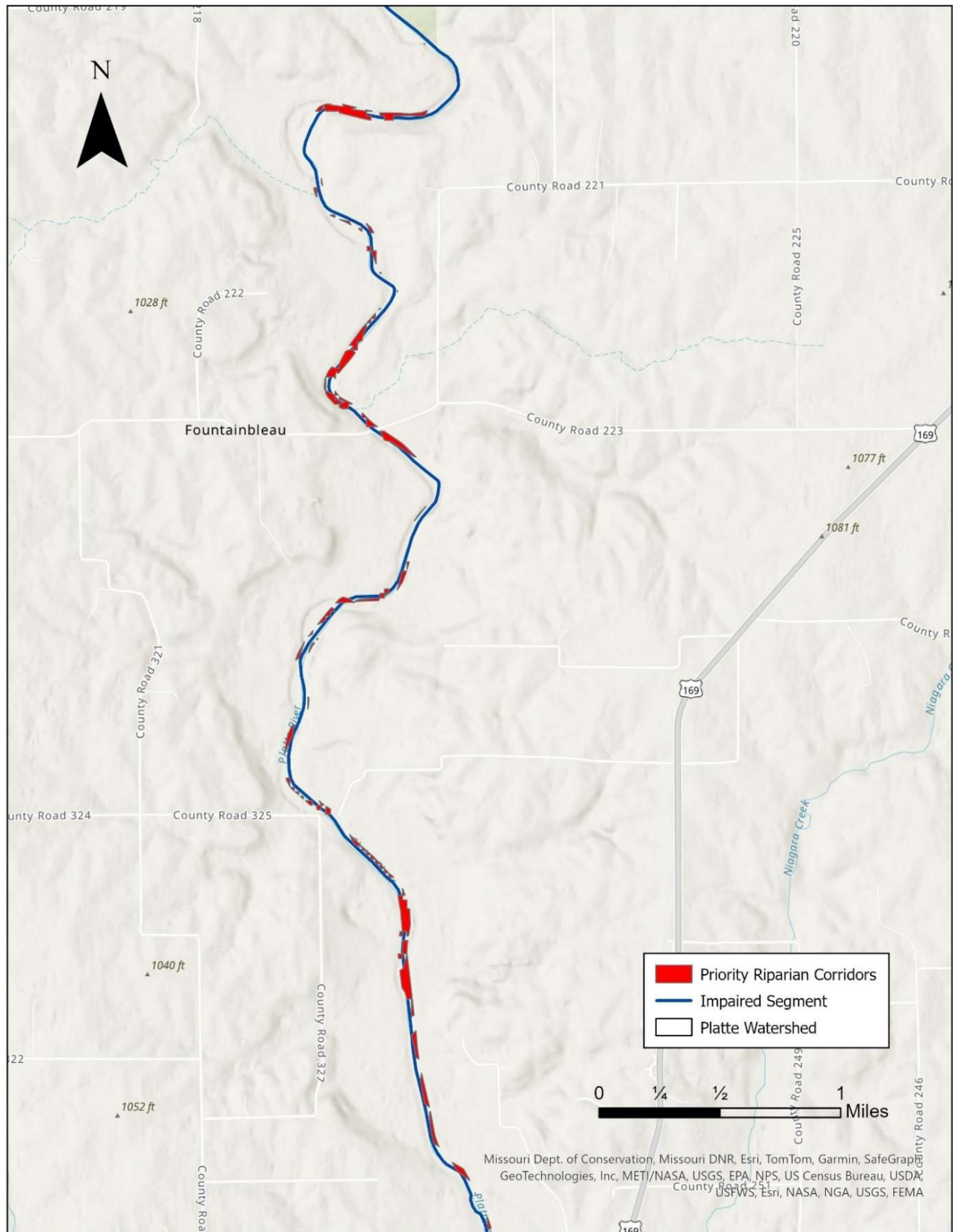


Figure E-9: Priority riparian corridors in the Platte River watershed in the central Platte River Watershed

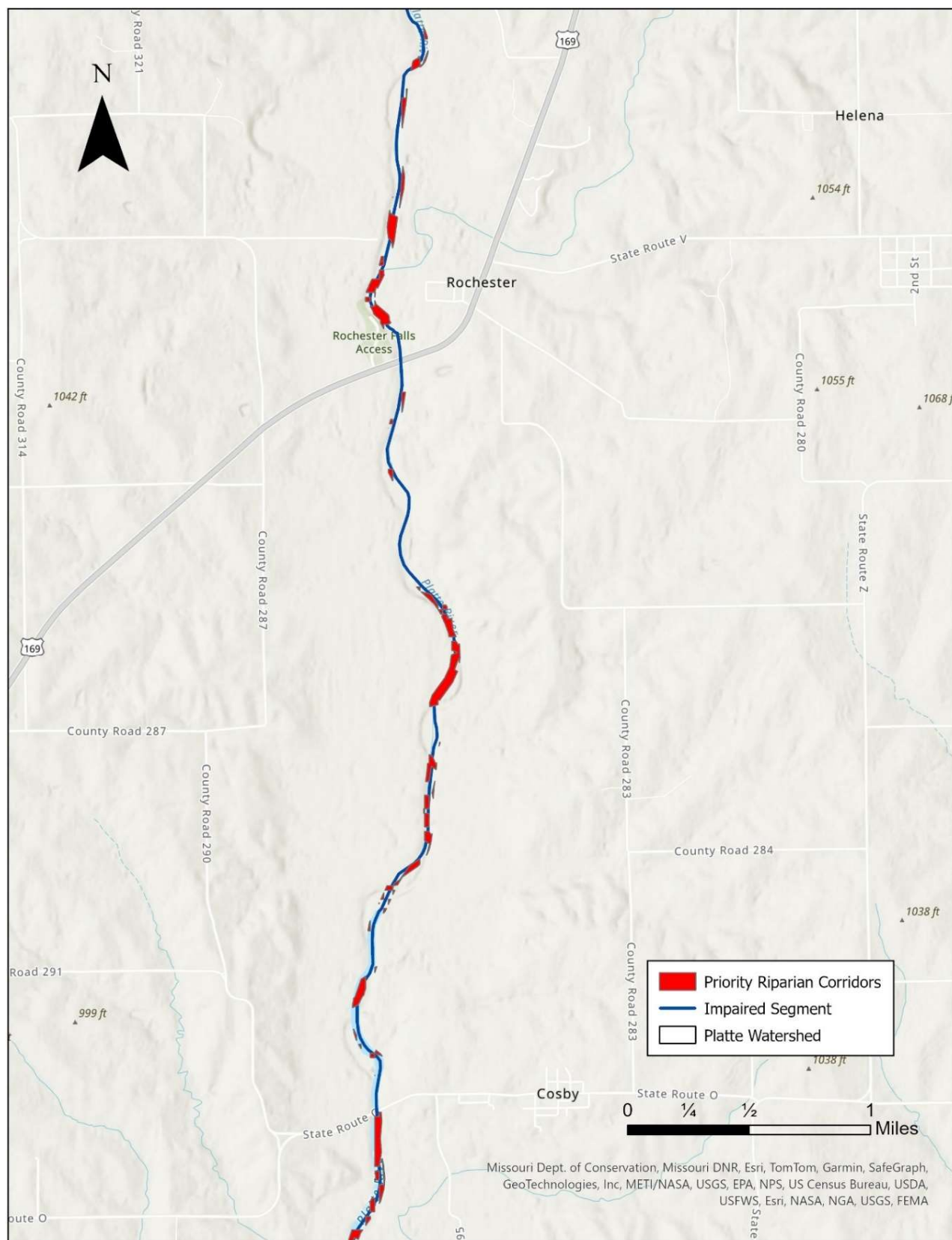


Figure E-10: Priority riparian corridors in the Platte River watershed in the central Platte River Watershed near Rochester, Missouri

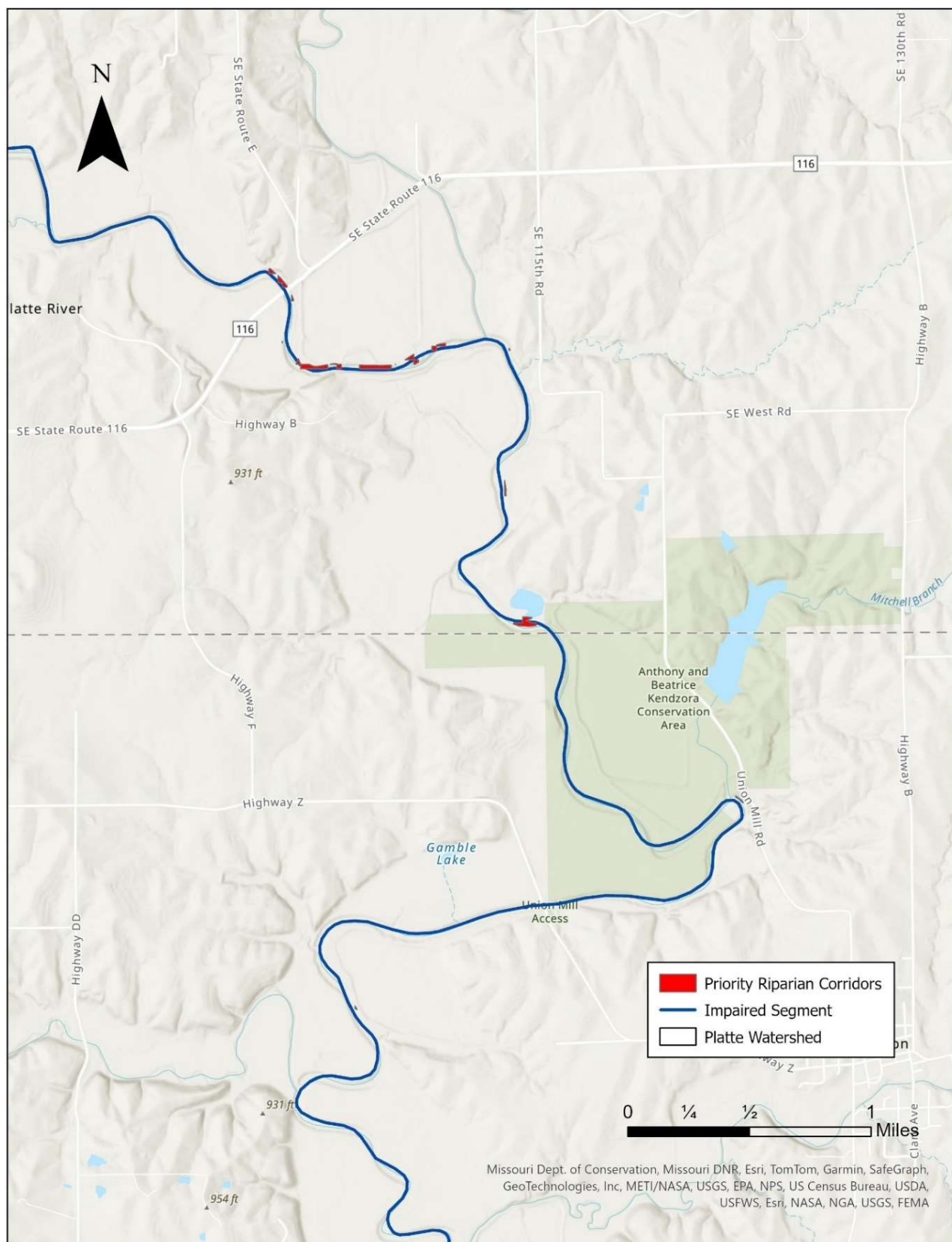


Figure E-11: Priority riparian corridors in the Platte River watershed in the south central Platte River Watershed

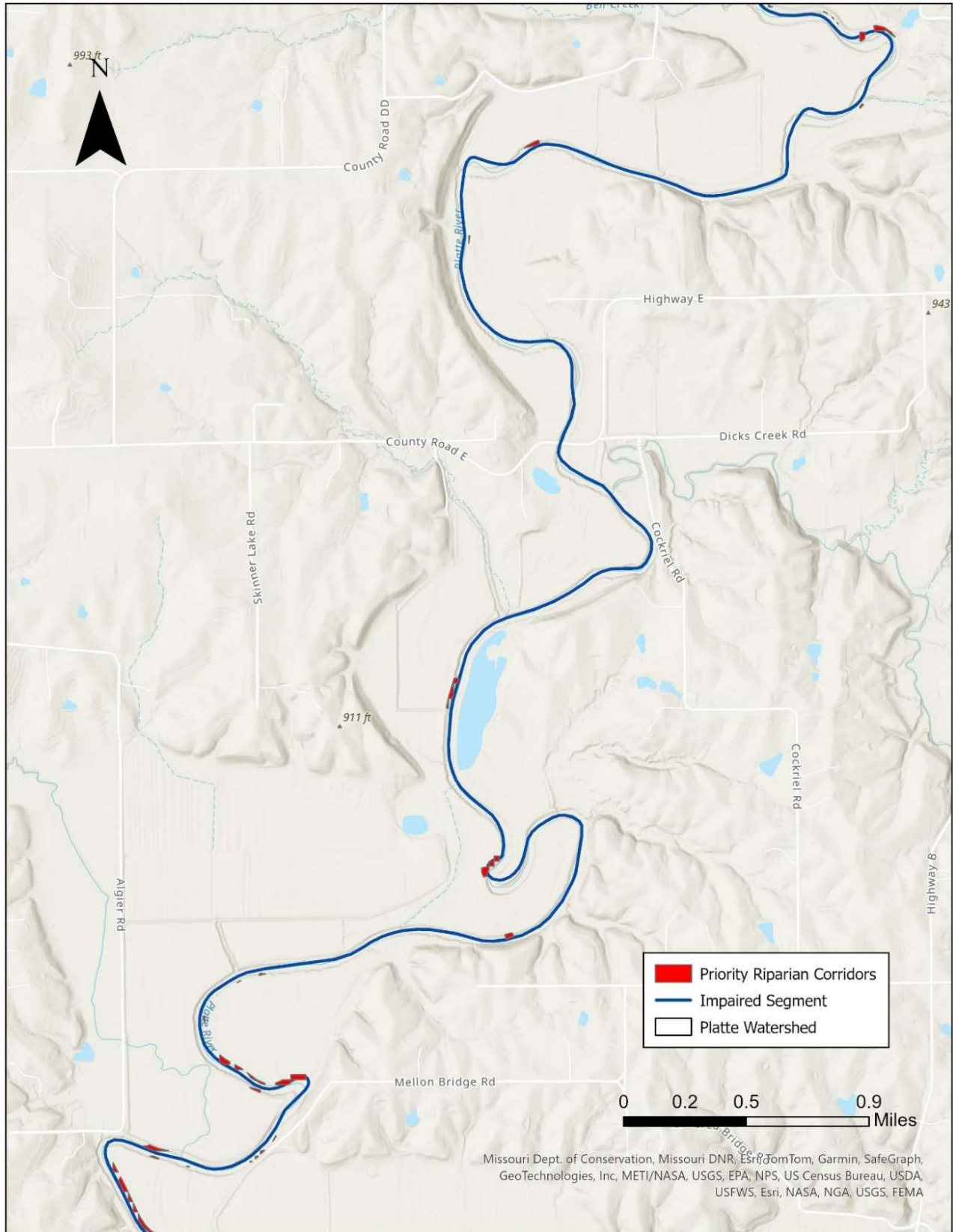


Figure E-12: Priority riparian corridors in the Platte River watershed at the southern Platte River Watershed

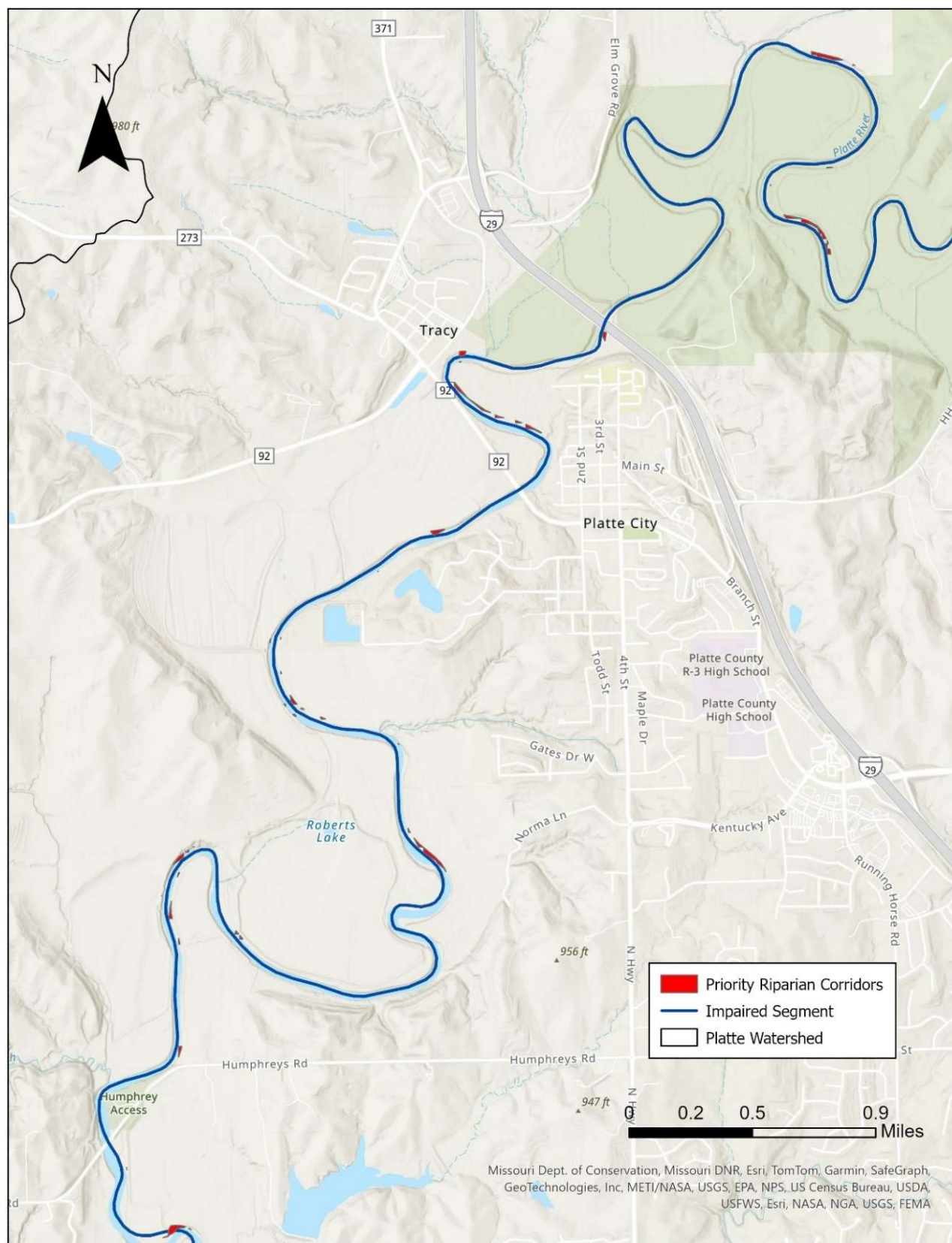


Figure E-13: Priority riparian corridors in the Platte River watershed in the southern Platte River Watershed near Platte City

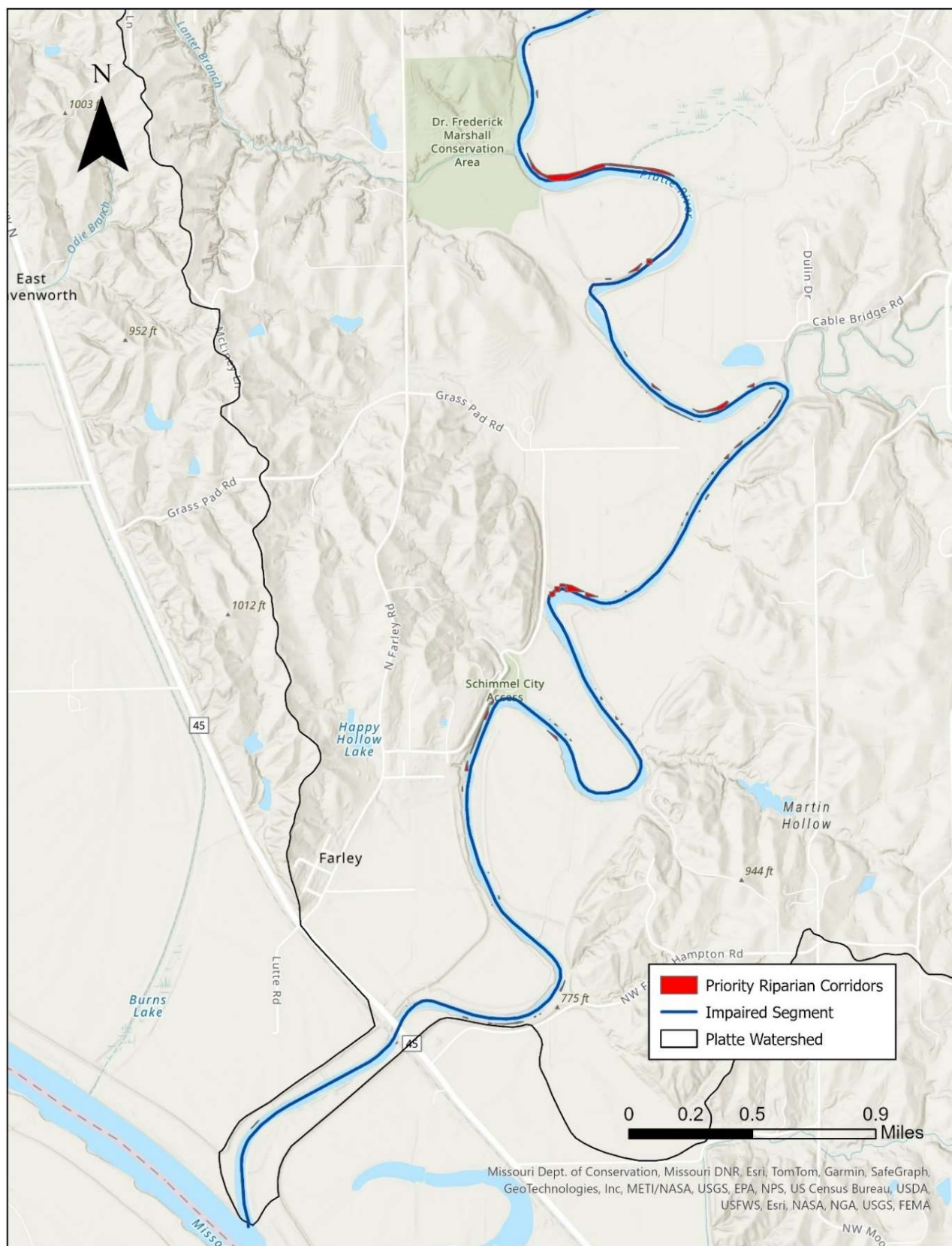


Figure E-14: Priority riparian corridors in the Platte River watershed at the end of the Platte River